

MEMORY FORENSICS VOLATILITY

FRAMEWORK & WORKBENCH

Table of Contents

Table of Contents	2
Abstract	4
Introduction	5
Memory Forensics	5
Memory Acquisition	6
Importance of Memory Acquisition	6
Memory Analysis	6
Volatility Framework	7
Data found using Volatility Framework	7
1. Imageinfo.....	7
2. Kdbgscan.....	8
3. Processes.....	8
PSlist	9
PSscan	10
PStree	10
4. DLL.....	11
DLLList	11
DLLDump	12
5. Handles.....	12
6. Getsids.....	13
7. Netscan.....	13
8. Hivelist.....	14
9. Timeliner.....	14
10. HashDump.....	15
11. Lsadump.....	15
12. Modscan.....	15
13. FileScan.....	16
14. Svcscan.....	16
15. Cmdscan.....	17
16. Iehistory.....	17
17. Dumpregistry.....	18
18. Moddump.....	18
19. Procdump.....	19
20. Memdump.....	19
21. Notepad.....	19

PassMark Volatility Workbench	20
Features of Volatility Workbench.....	20
1. Hunting rootkits and malicious code	20
2. Malfind.....	21
3. psxview.....	21
4. Timers.....	22
5. Getsids.....	22
6. Cmdscan.....	23
7. Consoles.....	23
8. Privs.....	24
9. Envars.....	24
10. Verinfo.....	25
11. Memmap.....	26
12. Vadinfo.....	26
13. Vadwalk.....	27
14. Vadtree.....	27
15. iehistory.....	28
16. Modules.....	28
17. SSDT.....	29
18. Driverscan.....	29
19. File Scan.....	30
20. Mutant scan.....	30
21. Thrdscan.....	31
22. Netscan.....	31
23. Hivelist.....	32
24. Hivescan.....	32
25. Printkey.....	33
26. Hashdump.....	33
27. Lsadump.....	34
28. Shellbags.....	34
29. Getservicesids.....	35
30. Dumpregistry.....	35
31. Mbrparser.....	36
32. Mftparser.....	37
References	37
About Us	38

Abstract

Cyber Criminals and **attackers** have become so creative in their crime type that they have started finding methods to hide data in the **volatile memory** of the systems. Today, in this article we are going to have a greater understanding of live **memory acquisition** and its **forensic analysis**. Live Memory acquisition is a method that is used to collect data when the system is found in an active state at the scene of the crime.

Memory forensics is a division of digital forensics that generally emphasizes extracting **artefacts** from the volatile memory of a system that was compromised. This domain is speedily spreading in cybercrime investigations. The main reason for this is that certain artefacts are extracted from system memory only and cannot be found anywhere else.

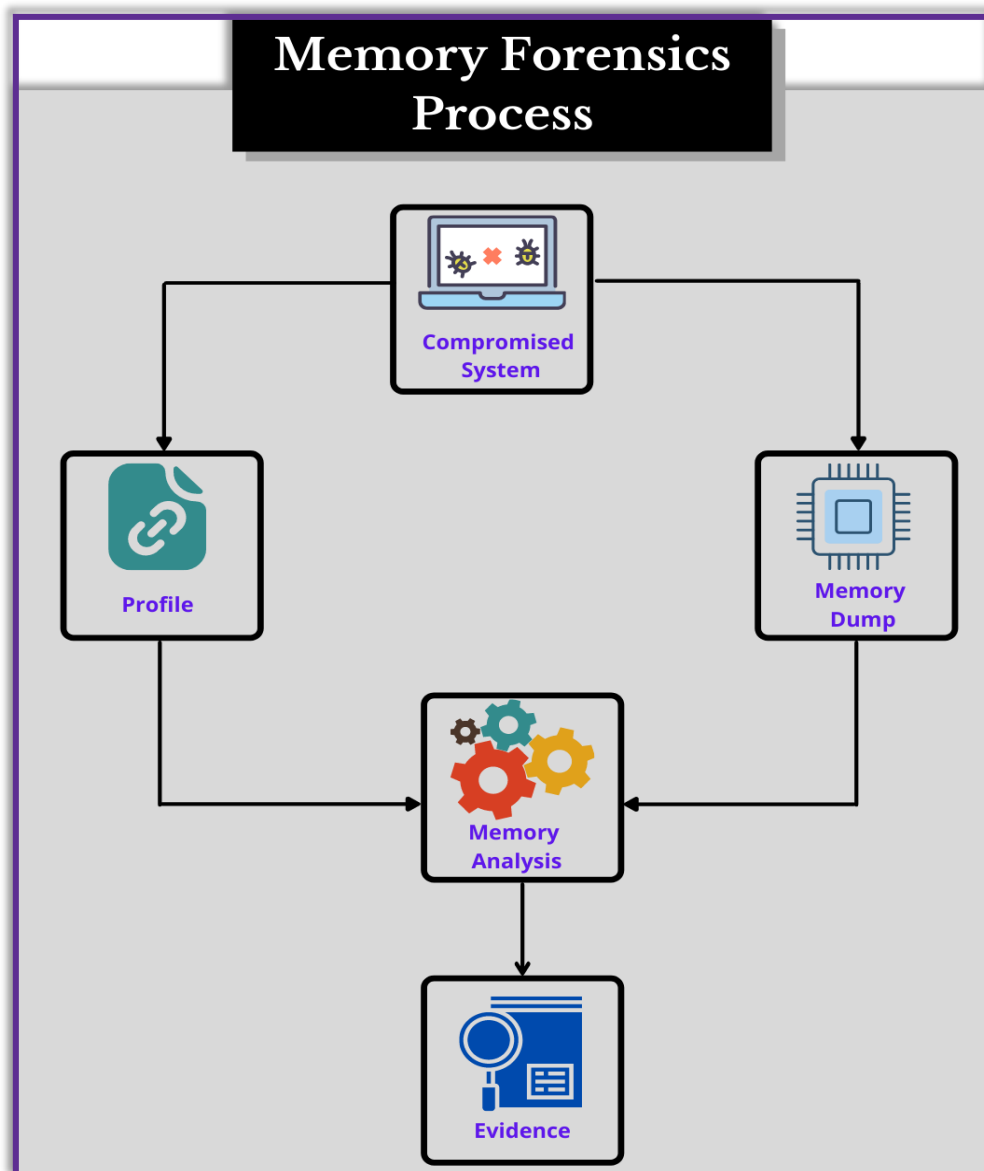
Analysing memory after **capturing the ram** is extremely important when it comes to collecting information on ports that were in use, the number of processes running, and the path of certain executables on the system while carrying out the investigation. The **Volatility Framework** is one such memory analysis tool that works on **command-line** on **Windows** and **Linux** systems.

Volatility Workbench is a **GUI version** of one of the same tool Volatility for analysing the artefacts from a memory dump. It is available free of cost, open-source, and runs on the Windows Operating system.

Introduction

Memory Forensics

Memory Forensics is a budding field in Digital Forensics Investigation which involves recovering, extracting and analysing evidence such as images, documents, or chat histories etc from the structured volatile memory into non-volatile devices like Hard-drives or USB drives.



NOTE: We have taken a memory dump of a Windows7 system using the Belkasoft RAM Capturer, which can be downloaded from [here](#).

Belkasoft
TECHNOLOGIES

Memory Acquisition

- It is the method of capturing and dumping the contents of a volatile content into a non-volatile storage device to preserve it for further investigation.
- A ram analysis can only be successfully conducted when the acquisition has been performed accurately without corrupting the image of the volatile memory.
- In this phase, the investigator has to be careful about his decisions to collect the volatile data as it won't exist after the system undergoes a reboot.
- The volatile memory can also be prone to alteration of any sort due to the continuous processes running in the background.
- Any external move made on the suspect system may impact the device's ram adversely.

Importance of Memory Acquisition

When a volatile memory is captured, the following artefacts can be discovered which can be useful to the investigation:

- On-going processes and recently terminated processes
- Files mapped in the memory (.exe, .txt, shared files, etc.)
- Any open TCP/UDP ports or any active connections
- Caches (clipboard data, SAM databases, edited files, passwords, web addresses, commands)
- Presence of hidden data, malware, etc.

Memory Analysis

Once the dump is available, we will begin with the forensic analysis of the memory using the Volatility Memory Forensics Framework which can be downloaded from [here](#). The volatility framework support analysis of **memory dump** from all the versions and services of Windows from **XP** to **Windows 10**. It also supports **Server 2003** to **Server 2016**. In this article, we will be analysing the memory dump in Kali Linux where Volatility comes pre-installed.



NOTE: Dump Format Supported- Raw format, Hibernation File, VM snapshot, Microsoft crash dump

Volatility Framework

Volatility Framework processes RAM dumps in various formats which can be used to process crash dumps, hibernation files and, page files that may be found on dumps of storage drives. RAM dumps from virtual machines or hypervisors can also be processed.

Data found using Volatility Framework

A huge amount of data can be availed on analysing volatile memory. It includes data like processes, information on open files, registry handles, information on the network and open ports, passwords and cryptographic keys, hidden data, worms and rootkits etc.

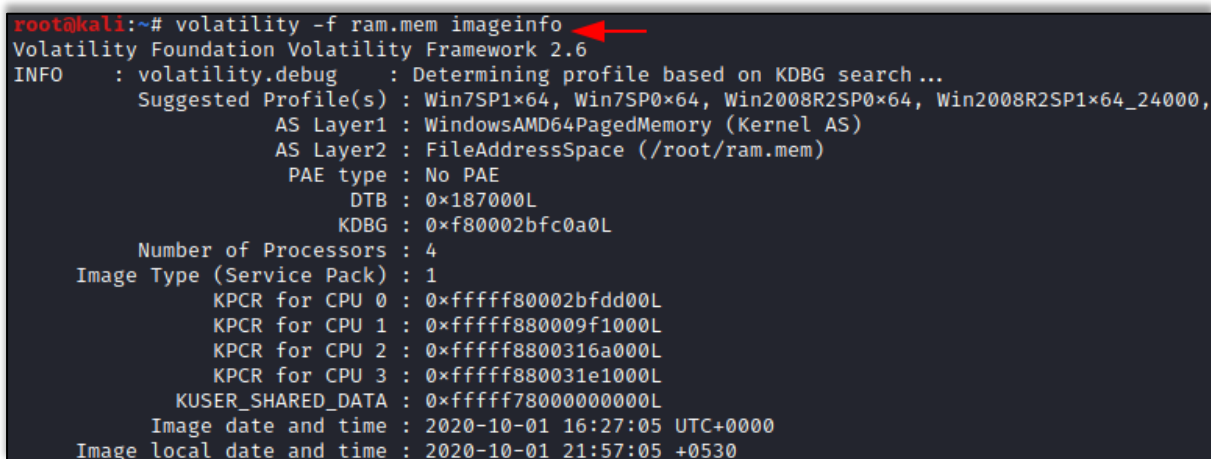
Switch on your Kali Linux Machines, and to get a basic list of all the available options, plugins, and flags to use in the analysis, you can type:

```
volatility -h
```

1. Imageinfo

When a Memory dump is taken, it is extremely important to know the information about the operating system that was in use. Volatility will try to read the image and suggest the related profiles for the given memory dump. The image info plugin displays the date and time of the sample that was collected, the number of CPUs present, etc. To obtain the details of the ram, you can type;

```
volatility -f ram.mem imageinfo
```



```
root@kali:~# volatility -f ram.mem imageinfo
Volatility Foundation Volatility Framework 2.6
INFO : volatility.debug : Determining profile based on KDBG search...
      Suggested Profile(s) : Win7SP1x64, Win7SP0x64, Win2008R2SP0x64, Win2008R2SP1x64_24000,
                           AS Layer1 : WindowsAMD64PagedMemory (Kernel AS)
                           AS Layer2 : FileAddressSpace (/root/ram.mem)
                           PAE type : No PAE
                           DTB : 0x187000L
                           KDBG : 0xf80002bfc0a0L
      Number of Processors : 4
      Image Type (Service Pack) : 1
      KPCR for CPU 0 : 0xfffff80002bfdd00L
      KPCR for CPU 1 : 0xfffff880009f1000L
      KPCR for CPU 2 : 0xfffff8800316a000L
      KPCR for CPU 3 : 0xfffff880031e1000L
      KUSER_SHARED_DATA : 0xfffff78000000000L
      Image date and time : 2020-10-01 16:27:05 UTC+0000
      Image local date and time : 2020-10-01 21:57:05 +0530
```

A profile is a categorization of specific operating systems, versions and their hardware architecture, A profile generally includes metadata information, system call information, etc. You may notice multiple profiles would be suggested to you.

2. Kdbgscan

This plugin finds and analyses the profiles based on the Kernel debugger data block. The Kdbgscan thus provides the correct profile related to the raw image. It is extremely important to get the right profile for memory analysis. To supply the correct profile for the memory analysis, type

```
volatility -f ram.mem kdbgscan
```

```
root@kali:~# volatility -f ram.mem kdbgscan
Volatility Foundation Volatility Framework 2.6
*****
Instantiating KDBG using: /root/ram.mem WinXPSP2x86 (5.1.0 32bit)
Offset (P)                : 0x2bfc0a0
KDBG owner tag check       : True
Profile suggestion (KDBGHeader): Win7SP1x64
PsActiveProcessHead        : 0x2c32b90
PsLoadedModuleList         : 0x2c50e90
KernelBase                 : 0xffffffff80002a0b000

*****
Instantiating KDBG using: /root/ram.mem WinXPSP2x86 (5.1.0 32bit)
Offset (P)                : 0x2bfc0a0
KDBG owner tag check       : True
Profile suggestion (KDBGHeader): Win7SP0x64
PsActiveProcessHead        : 0x2c32b90
PsLoadedModuleList         : 0x2c50e90
KernelBase                 : 0xffffffff80002a0b000

*****
Instantiating KDBG using: /root/ram.mem WinXPSP2x86 (5.1.0 32bit)
Offset (P)                : 0x2bfc0a0
KDBG owner tag check       : True
Profile suggestion (KDBGHeader): Win2008R2SP1x64
PsActiveProcessHead        : 0x2c32b90
PsLoadedModuleList         : 0x2c50e90
KernelBase                 : 0xffffffff80002a0b000
```

3. Processes

When a system is in an active state it is normal for it to have multiple processes running in the background and can be found in the volatile memory. It consists of executable program code, imported libraries, allocated memory, execution threads. The presence of any hidden process can also be parsed out of a memory dump. The recently terminated processes before the reboot can also be recorded and analysed in the memory dump. There are a few plugins that can be used to list the processes to carry out forensic investigation.

PSlist

To identify the presence of any rogue processes and to view any high-level running processes.

On executing this command, the list of processes running is displayed, their respective process ID assigned to them and the parent process ID is also displayed along. The details about the threads, sessions, handles are also mentioned. The timestamp according to the start of the process is also displayed. This helps to identify whether an unknown process is running or was running at an unusual time. It will not give information about processes that were hidden by removing themselves from the process list or the ones that were terminated before

```
volatility -f ram.mem --profile=Win7SP1x64 pslist -P
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 pslist -P
Volatility Foundation Volatility Framework 2.6
Offset(P)      Name                PID    PPID    Thds    Hnds    Sess    Wow64    Start
0x000000013fece890 System                4        0     103     542      0      0  0 2020-10-01 16:24:31 UTC+0000
0x000000013f4a02f0 smss.exe             268        4        2       32      0      0  0 2020-10-01 16:24:31 UTC+0000
0x000000013ed04060 csrss.exe            352       344        9     504      0      0  0 2020-10-01 16:24:35 UTC+0000
0x000000013ead82f0 csrss.exe            408       400       10     279      1      0  0 2020-10-01 16:24:36 UTC+0000
0x000000013ead2a90 wininit.exe          416       344        3       78      0      0  0 2020-10-01 16:24:36 UTC+0000
0x000000013eb12060 winlogon.exe          464       400        4     115      1      0  0 2020-10-01 16:24:36 UTC+0000
0x000000013eb32780 services.exe          512       416       11     229      0      0  0 2020-10-01 16:24:37 UTC+0000
0x000000013eb68450 lsass.exe            520       416        8     595      0      0  0 2020-10-01 16:24:38 UTC+0000
0x000000013eb69600 lsm.exe              528       416       12     203      0      0  0 2020-10-01 16:24:38 UTC+0000
0x000000013eba9b30 svchost.exe          620       512       12     376      0      0  0 2020-10-01 16:24:39 UTC+0000
0x000000013ebe7b30 svchost.exe          704       512        7     289      0      0  0 2020-10-01 16:24:39 UTC+0000
0x000000013e830b30 svchost.exe          800       512       23     448      0      0  0 2020-10-01 16:24:40 UTC+0000
0x000000013e848890 svchost.exe          840       512       20     433      0      0  0 2020-10-01 16:24:40 UTC+0000
0x000000013e853b30 svchost.exe          868       512       49    1114      0      0  0 2020-10-01 16:24:40 UTC+0000
0x000000013e87bb30 audiodg.exe          944       800        6     130      0      0  0 2020-10-01 16:24:40 UTC+0000
0x000000013e8a9b30 svchost.exe          128       512       12     550      0      0  0 2020-10-01 16:24:41 UTC+0000
0x000000013e8ce060 svchost.exe          400       512       25     634      0      0  0 2020-10-01 16:24:41 UTC+0000
0x000000013e9331b0 spoolsv.exe          1040      512       14     289      0      0  0 2020-10-01 16:24:43 UTC+0000
0x000000013e94a060 svchost.exe          1084      512       20     340      0      0  0 2020-10-01 16:24:43 UTC+0000
0x000000013e661b30 VGAuthService        1308      512        5     100      0      0  0 2020-10-01 16:24:44 UTC+0000
0x000000013e698b30 vmtoolsd.exe         1368      512       13     274      0      0  0 2020-10-01 16:24:46 UTC+0000
0x000000013ff2f4f0 svchost.exe          1600      512        8      97      0      0  0 2020-10-01 16:24:48 UTC+0000
0x000000013e7717c0 dllhost.exe          1748      512       22     213      0      0  0 2020-10-01 16:24:48 UTC+0000
0x000000013e78e9e0 dllhost.exe          1920      512       17     213      0      0  0 2020-10-01 16:24:50 UTC+0000
0x000000013e42db30 msdtc.exe            2000      512       16     158      0      0  0 2020-10-01 16:24:50 UTC+0000
0x000000013fe79b30 WmiPrvSE.exe         1840      620       12     202      0      0  0 2020-10-01 16:24:54 UTC+0000
0x000000013e525b30 VSSVC.exe            2060      512        6     121      0      0  0 2020-10-01 16:24:54 UTC+0000
0x000000013faba920 WmiPrvSE.exe         2124      620       13     310      0      0  0 2020-10-01 16:25:08 UTC+0000
0x000000013e5d0b30 taskhost.exe         2268      512        9     167      1      0  0 2020-10-01 16:25:25 UTC+0000
0x000000013e21c9e0 sppsvc.exe           2396      512        4     157      0      0  0 2020-10-01 16:25:26 UTC+0000
0x000000013e4aa200 dwm.exe              2568      840        6     137      1      0  0 2020-10-01 16:25:32 UTC+0000
0x000000013e88cb30 explorer.exe         2592     2560       44     990      1      0  0 2020-10-01 16:25:32 UTC+0000
0x000000013e2f9060 vm3dservice.exe      2684     2592        3      45      1      0  0 2020-10-01 16:25:34 UTC+0000
0x000000013e268b30 vmtoolsd.exe         2696     2592        9     222      1      0  0 2020-10-01 16:25:34 UTC+0000
0x000000013e37ab30 SearchIndexer        2896      512       15     629      0      0  0 2020-10-01 16:25:40 UTC+0000
0x000000013e3c4710 SearchProtocol        2972     2896        8     233      1      0  0 2020-10-01 16:25:41 UTC+0000
0x000000013e3d57c0 SearchFilterHo       2992     2896        4      86      0      0  0 2020-10-01 16:25:41 UTC+0000
0x000000013e0a36c0 RamCapture64.e       2836     2592        4      74      1      0  0 2020-10-01 16:25:54 UTC+0000
0x000000013e0d8460 conhost.exe          2840      408        3      51      1      0  0 2020-10-01 16:25:54 UTC+0000
0x000000013e360700 notepad.exe          788      2592        3      82      1      0  0 2020-10-01 16:26:04 UTC+0000
0x000000013ff75060 svchost.exe          2764      512        6      73      0      0  0 2020-10-01 16:26:48 UTC+0000
0x000000013e62bb30 svchost.exe          2752      512       14     342      0      0  0 2020-10-01 16:26:48 UTC+0000
0x000000013ecc8630 iexplore.exe         1116     2592       18     421      1      0  0 2020-10-01 16:26:51 UTC+0000
0x000000013ed13900 iexplore.exe         2412     1116       18     366      1      0  0 2020-10-01 16:26:55 UTC+0000
0x000000013e83b060 putty.exe            1936     2592        2      88      1      1  1 2020-10-01 16:27:00 UTC+0000
0x000000013ffde060 WmiApSrv.exe         2164      512        7     121      0      0  0 2020-10-01 16:27:11 UTC+0000
0x000000013e5f9b30 sdclt.exe            2176      512        1      18      0      0  0 2020-10-01 16:27:43 UTC+0000
0x000000013e271b30 wsqmcons.exe         3020      512        1     257      0      0  0 2020-10-01 16:27:43 UTC+0000
0x000000013ebcc240 taskhost.exe         1776      512        5    6684773 0      0  0 2020-10-01 16:27:43 UTC+0000
```

PSscan

This plugin can be used to give a detailed list of processes found in the memory dump. On executing this command, the list of processes running is displayed, their respective process ID assigned to them and the parent process ID is also displayed along. The details about the threads, sessions, handles are also mentioned. The timestamp according to the start of the process is also displayed. This helps to identify whether an unknown process is running or was running at an unusual time

```
volatility -f ram.mem --profile=Win7SP1x64 psscan
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 psscan
Volatility Foundation Volatility Framework 2.6
```

Offset(P)	Name	PID	PPID	PDB	Time created
0x000000013e0a36c0	RamCapture64.e	2836	2592	0x00000000071ec4000	2020-10-01 16:25:54 UTC+0000
0x000000013e0d8460	conhost.exe	2840	408	0x00000000071a49000	2020-10-01 16:25:54 UTC+0000
0x000000013e21c9e0	sppsvc.exe	2396	512	0x000000000893d4000	2020-10-01 16:25:26 UTC+0000
0x000000013e268b30	vmtoolsd.exe	2696	2592	0x0000000007ffab000	2020-10-01 16:25:34 UTC+0000
0x000000013e271b30	wsqmcons.exe	3020	512	0x000000001297c4000	2020-10-01 16:27:43 UTC+0000
0x000000013e2f9060	vm3dservice.ex	2684	2592	0x000000000804a6000	2020-10-01 16:25:34 UTC+0000
0x000000013e360700	notepad.exe	788	2592	0x00000000072e8e000	2020-10-01 16:26:04 UTC+0000
0x000000013e37ab30	SearchIndexer.	2896	512	0x0000000007d35d000	2020-10-01 16:25:40 UTC+0000
0x000000013e3c4710	SearchProtocol	2972	2896	0x00000000086f7b000	2020-10-01 16:25:41 UTC+0000
0x000000013e3d57c0	SearchFilterHo	2992	2896	0x0000000007be61000	2020-10-01 16:25:41 UTC+0000

PStree

In this plugin, the process list is represented with a child-parent relationship and shows any unknown or abnormal processes. The child process is represented by indentation and periods.

```
volatility -f ram.mem --profile=Win7SP1x64 pstree
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 pstree
Volatility Foundation Volatility Framework 2.6
```

Name	Pid	PPid	Thds	Hnds	Time
0xfffffa80322d2a90:wininit.exe	416	344	3	78	2020-10-01 16:25:54 UTC+0000
. 0xfffffa8032332780:services.exe	512	416	11	229	2020-10-01 16:25:54 UTC+0000
.. 0xfffffa80324a9b30:svchost.exe	128	512	12	550	2020-10-01 16:25:54 UTC+0000
.. 0xfffffa80325331b0:spoolsv.exe	1040	512	14	289	2020-10-01 16:25:54 UTC+0000
.. 0xfffffa80323e7b30:svchost.exe	704	512	7	289	2020-10-01 16:25:54 UTC+0000
.. 0xfffffa803282db30:msdtc.exe	2000	512	16	158	2020-10-01 16:25:54 UTC+0000
.. 0xfffffa8032661b30:VGAuthService.	1308	512	5	100	2020-10-01 16:25:54 UTC+0000
.. 0xfffffa803254a060:svchost.exe	1084	512	20	340	2020-10-01 16:25:54 UTC+0000
.. 0xfffffa8030f2f4f0:svchost.exe	1600	512	8	97	2020-10-01 16:25:54 UTC+0000

4. DLL

It is extremely important to know which DLLs (Dynamic Linked Libraries) are imported into the process while analysing the memory dump. A DLL can contain malicious executable code that may have a benign process to introduce malicious activity. Therefore, examining the various processes for the presence of malicious DLLs or similar code injections is crucial for analysis. Volatility has various types of plugins for this analysis.

DLList

Various tools only have the potential to detect the DLLs which are used by a process by consulting the first of the three DLL lists stored in the PEB, which tracks the order in which each DLL is loaded. As a result, malware will sometimes modify that list to hide the presence of a DLL. Volatility has a plugin that also parses this same list, which can be run with the following command:

```
volatility -f ram.mem --profile=Win7SP1x64 dlllist -p 116,788
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 dlllist -p 1116,788
Volatility Foundation Volatility Framework 2.6
*****
notepad.exe pid: 788
Command line : "C:\Windows\system32\notepad.exe" C:\Users\raj\Desktop\New Text Document.txt
Service Pack 1
```

Base	Size	LoadCount	LoadTime	Path
0x0000000ffa60000	0x35000	0xffff	1970-01-01 00:00:00 UTC+0000	C:\Windows
0x000000077490000	0x1a9000	0xffff	1970-01-01 00:00:00 UTC+0000	C:\Windows
0x000000077370000	0x11f000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fef4d0000	0x6b000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefa40000	0xdb000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefeec0000	0x9f000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007feff580000	0x1f000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefb20000	0x12d000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefe7b0000	0x67000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000000077270000	0xfa000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007feff570000	0xe000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fef6d0000	0xc9000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefe820000	0x97000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007feff4d0000	0x71000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefbbf0000	0x1f4000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fed850000	0xd88000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fef8050000	0x71000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefecb0000	0x203000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007feff190000	0xd7000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefc540000	0xc000	0xffff	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefe5e0000	0x2e000	0x4	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fefe690000	0x109000	0x2	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007fed2d0000	0xf000	0x1	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007feb970000	0x56000	0x3	2020-10-01 16:26:04 UTC+0000	C:\Windows
0x0000007feb080000	0x18000	0x1	2020-10-01 16:26:04 UTC+0000	C:\Windows

```
*****
iexplore.exe pid: 1116
Command line : "C:\Program Files\Internet Explorer\iexplore.exe"
Service Pack 1
```

Base	Size	LoadCount	LoadTime	Path
0x0000000000210000	0xac000	0xffff	1970-01-01 00:00:00 UTC+0000	C:\Program
0x0000000077490000	0x1a9000	0xffff	1970-01-01 00:00:00 UTC+0000	C:\Windows

DLLDump

This plugin is used to dump the DLLs from the memory space of the processes into another location to analyze it. To take a dump of the DLLs you can type,

```
volatility -f ram.mem --profile=Win7SP1x64 dlldump -dump-dir
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 dlldump --dump-dir /root/ramdump/
Volatility Foundation Volatility Framework 2.6
```

Process(V)	Name	Module Base	Module Name	Result
0xfffffa80318a02f0	smss.exe	0x0000000047850000	smss.exe	OK: module.268.13f4a
0xfffffa80318a02f0	smss.exe	0x0000000077490000	ntdll.dll	OK: module.268.13f4a
0xfffffa8032104060	csrss.exe	0x000000004a520000	csrss.exe	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x0000000077490000	ntdll.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7d440000	basesrv.DLL	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7f6d0000	USP10.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x0000000077270000	USER32.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7d460000	CSRSRV.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x0000000077370000	kernel32.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7eb20000	RPCRT4.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7d2d0000	CRYPTBASE.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7d2e0000	GDI32.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7e0c0000	msvcrt.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7f570000	LPK.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7d4d0000	KERNELBASE.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7d2e0000	sxs.dll	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7d3f0000	xsxssrv.DLL	OK: module.352.13ed0
0xfffffa8032104060	csrss.exe	0x000007fe7d400000	winsrv.DLL	OK: module.352.13ed0
0xfffffa80322d82f0	csrss.exe	0x000000004a520000	csrss.exe	OK: module.408.13ead

5. Handles

This plugin is used to display the open handles that are present in a process. This plugin applies to files, registry keys, events, desktops, threads, and all other types of objects. To see the handles, present in the dump, you can type,

```
volatility -f ram.mem --profile=Win7SP1x64 handles
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 handles
Volatility Foundation Volatility Framework 2.6
```

Offset(V)	Pid	Handle	Access	Type	Details
0xfffffa8030ece890	4	0x4	0x1fffff	Process	System(4)
0xfffffa80000711f0	4	0x8	0x2001f	Key	MACHINE\CONTROLSET
0xfffffa8000008060	4	0xc	0xf000f	Directory	GLOBAL ??
0xfffffa800001aca0	4	0x10	0x0	Key	
0xfffffa800008ed30	4	0x14	0x2001f	Key	MACHINE\CONTROLSET
0xfffffa8000072fa0	4	0x18	0xf003f	Key	MACHINE\CONTROLSET
0xfffffa800008ee20	4	0x1c	0x2001f	Key	MACHINE\SETUP
0xfffffa8030efea40	4	0x20	0x1f0001	ALPC Port	PowerMonitorPort
0xfffffa8030f0a070	4	0x24	0x1f0001	ALPC Port	PowerPort
0xfffffa8000072ba0	4	0x28	0x20019	Key	MACHINE\DESCRIPTIO
0xfffffa8030ff57e0	4	0x2c	0x1fffff	Thread	TID 172 PID 4
0xfffffa800008fa90	4	0x30	0xf003f	Key	MACHINE\CONTROLSET
0xfffffa800008be80	4	0x34	0xf003f	Key	MACHINE\CONTROLSET
0xfffffa8000057fa0	4	0x38	0xf003f	Key	MACHINE\CONTROLSET

6. Getsids

This plugin is used to view the SIDs stands for Security Identifiers that are associated with a process. This plugin can help in identifying processes that have maliciously escalated privileges and which processes belong to specific users. To get detail on a particular process id, you can type:

```
volatility -f ram.mem --profile=Win7SP1x64 getsids -p 464
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 getsids -p 464
Volatility Foundation Volatility Framework 2.6
winlogon.exe (464): S-1-5-18 (Local System)
winlogon.exe (464): S-1-5-32-544 (Administrators)
winlogon.exe (464): S-1-1-0 (Everyone)
winlogon.exe (464): S-1-5-11 (Authenticated Users)
winlogon.exe (464): S-1-16-16384 (System Mandatory Level)
root@kali:~#
```

7. Netscan

This plugin helps in finding network-related artifacts present in the memory dump. It makes use of pool tag scanning. This plugin finds all the TCP endpoints, TCP listeners, UDP endpoints, and UDP listeners. It provides details about the local and remote IP and also about the local and remote port. To get details on the network artifacts, you can type:

```
volatility -f ram.mem --profile=Win7SP1x64 netscan
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 netscan
Volatility Foundation Volatility Framework 2.6
```

Offset(P)	Proto	Local Address	Foreign Address	State
0x13e0de9e0	UDPv4	127.0.0.1:65024	*:*	
0x13e8dcce0	UDPv4	0.0.0.0:0	*:*	
0x13e8dcce0	UDPv6	:::0	*:*	
0x13e8e4ad0	UDPv4	0.0.0.0:5355	*:*	
0x13e9c2d60	UDPv4	0.0.0.0:4500	*:*	
0x13e9c2d60	UDPv6	:::4500	*:*	
0x13e9d9270	UDPv4	0.0.0.0:4500	*:*	
0x13e9d9930	UDPv4	0.0.0.0:500	*:*	
0x13e9de010	UDPv4	0.0.0.0:500	*:*	
0x13e9de010	UDPv6	:::500	*:*	
0x13e9de500	UDPv4	0.0.0.0:0	*:*	
0x13e9de500	UDPv6	:::0	*:*	
0x13e9deb10	UDPv4	0.0.0.0:0	*:*	
0x13e9deb10	UDPv4	192.168.2.11:138	*:*	
0x13eb35920	UDPv4	192.168.2.11:137	*:*	
0x13e6fb790	TCPv4	0.0.0.0:49155	0.0.0.0:0	LISTENING
0x13e6fbef0	TCPv4	0.0.0.0:445	0.0.0.0:0	LISTENING

8. Hivelist

This plugin can be used to locate the virtual addresses present in the registry hives in memory, and their entire paths to hive on the disk. To obtain the details on the hivelist from the memory dump, you can type:

```
volatility -f ram.mem --profile=Win7SP1x64 hivelist
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 hivelist
Volatility Foundation Volatility Framework 2.6
Virtual          Physical      Name
-----
0xfffff8a00000f010 0x00000000a97f2010 [no name]
0xfffff8a0000024010 0x00000000a987d010 \REGISTRY\MACHINE\SYSTEM
0xfffff8a0000057010 0x00000000a95b0010 \REGISTRY\MACHINE\HARDWARE
0xfffff8a0000058a010 0x00000000a8270010 \SystemRoot\System32\Config\SECURITY
0xfffff8a0000058c010 0x00000000a83f2010 \SystemRoot\System32\Config\SOFTWARE
0xfffff8a0000058f010 0x000000009d700010 \SystemRoot\System32\Config\DEFAULT
0xfffff8a000005ff010 0x00000000a8182010 \SystemRoot\System32\Config\SAM
0xfffff8a00000e4d010 0x000000009d4e5010 \??\C:\Windows\ServiceProfiles\NetworkService\N
0xfffff8a00000eef010 0x000000009d536010 \??\C:\Windows\ServiceProfiles\LocalService\NTU
0xfffff8a0015d7010 0x000000008a545010 \??\C:\Users\raj\ntuser.dat
0xfffff8a0015e5010 0x000000008aa5c010 \??\C:\Users\raj\AppData\Local\Microsoft\Window
0xfffff8a0021c8010 0x00000000610c4010 \??\C:\System Volume Information\Syscache.hve
0xfffff8a00307c010 0x00000000a58f7010 \Device\HarddiskVolume1\Boot\BCD
```

9. Timeliner

This plugin usually creates a timeline from the various artifacts found in the memory dump. To locate the artifacts according to the timeline, you can use the following command:

```
volatility -f ram.mem --profile=Win7SP1x64 timeliner
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 timeliner
Volatility Foundation Volatility Framework 2.6
2020-10-01 16:27:05 UTC+0000 [LIVE RESPONSE] (System time)
2020-10-01 16:26:04 UTC+0000 [IEHISTORY] explorer.exe→Visited: raj@file:///C:/Users/raj/De
2020-09-26 11:42:11 UTC+0000 [IEHISTORY] explorer.exe→Visited: raj@file:///C:/Users/raj/De
2020-09-17 17:43:58 UTC+0000 [IEHISTORY] explorer.exe→Visited: raj@file:///E:/raj.txt| PID
2020-09-26 11:48:11 UTC+0000 [IEHISTORY] explorer.exe→Visited: raj@file:///C:/Users/raj/De
2020-10-01 21:56:04 UTC+0000 [IEHISTORY] explorer.exe->:2020100120201002: raj@file:///C:/Us
2020-10-01 21:56:04 UTC+0000 [IEHISTORY] explorer.exe->:2020100120201002: raj@Host: Comput
2020-10-01 16:26:04 UTC+0000 [IEHISTORY] iexplore.exe→Visited: raj@file:///C:/Users/raj/De
2020-09-26 11:42:11 UTC+0000 [IEHISTORY] iexplore.exe→Visited: raj@file:///C:/Users/raj/De
2020-09-17 17:43:58 UTC+0000 [IEHISTORY] iexplore.exe→Visited: raj@file:///E:/raj.txt| PID
2020-09-26 11:48:11 UTC+0000 [IEHISTORY] iexplore.exe→Visited: raj@file:///C:/Users/raj/De
```

10. HashDump

This plugin can be used to extract and decrypt cached domain credentials stored in the registry which can be availed from the memory dump. The hashes that are availed from the memory dump can be cracked using John the Ripper, Hashcat, etc. To gather the hashdump, you can use the command:

```
volatility -f ram.mem --profile=Win7SP1x64 hashdump
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 hashdump
Volatility Foundation Volatility Framework 2.6
Administrator:500:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
Guest:501:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
raj:1000:aad3b435b51404eeaad3b435b51404ee:3dbde697d71690a769204beb12283678:::
ignite:1001:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
```

11. Lsadbump

This plugin is used to dump LSA secrets from the registry in the memory dump. This plugin gives out information like the default password, the RDP public key, etc. To perform a lsadbump, you can type the following command:

```
volatility -f ram.mem --profile=Win7SP1x64 lsadbump
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 lsadbump
Volatility Foundation Volatility Framework 2.6
DefaultPassword
0x00000000 08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0x00000010 31 00 32 00 33 00 34 00 00 00 00 00 00 00 00 1.2.3.4.....

DPAPI_SYSTEM
0x00000000 2c 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ,.....
```

12. Modscan

This plugin is used to locate kernel memory and its related objects. It can pick up all the previously unloaded drivers and also those drivers that have been hidden or have been unlinked by rootkits in the system.

```
volatility -f ram.mem --profile=Win7SP1x64 modscan
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 modscan
Volatility Foundation Volatility Framework 2.6
```

Offset(P)	Name	Base	Size	File
0x0000000002fa45e1		0x894c304b8b48ffad	0x8435e800	
0x0000000005bdeb5e1		0x894c304b8b48ffad	0x8435e800	
0x0000000013e230c00	spsys.sys	0xfffff88005a00000	0x71000	\SystemRoot\
0x0000000013e2be010	RamCaptur ... er64.SYS	0xfffff88005a71000	0x7000	\??\C:\User:
0x0000000013e611350	secdrv.SYS	0xfffff88005927000	0xb000	\SystemRoot\
0x0000000013e6171b0	srvnet.sys	0xfffff88005932000	0x31000	\SystemRoot\
0x0000000013e629520	rdpdr.sys	0xfffff88005b7d000	0x2e000	\SystemRoot\
0x0000000013e634480	srv2.sys	0xfffff88005975000	0x6b000	\SystemRoot\

13. FileScan

This plugin is used to find FILE_OBJECTs present in the physical memory by using pool tag scanning. It can find open files even if there is a hidden rootkit present in the files. To make use of this plugin, you can type the following command:

```
volatility -f ram.mem --profile=Win7SP1x64 filescan
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 filescan
Volatility Foundation Volatility Framework 2.6
Offset(P)      #Ptr  #Hnd Access Name
-----
0x000000013e000910    1    1 RW-rw- \Device\HarddiskVolume1\Users\raj\AppData\Local\Microsof
0x000000013e00c4a0    2    1 ----- \Device\NamedPipe\MsFteWds
0x000000013e00c740    2    0 R--r-d \Device\HarddiskVolume1\Windows\System32\rasdlg.dll
0x000000013e00c9f0    1    0 RW-rwd \Device\HarddiskVolume1\$\PrepareToShrinkFileSize
0x000000013e01baf0   12    0 R--r-d \Device\HarddiskVolume1\Windows\System32\wlanutil.dll
0x000000013e01d6e0    1    1 R--rw- \Device\HarddiskVolume1\Windows\winsxs\amd64_microsoft..
0x000000013e020560   14    0 R--r-- \Device\HarddiskVolume1\wkssvc
0x000000013e020920    4    0 R--r-d \Device\HarddiskVolume1\Windows\System32\WwanAPI.dll
0x000000013e021a70   18    1 RW-r-- \Device\HarddiskVolume1\Windows\System32\winevt\Logs\Mi
0x000000013e021dd0   12    0 R--r-d \Device\HarddiskVolume1\Windows\System32\wwapi.dll
0x000000013e021f20    5    0 R--r-d \Device\HarddiskVolume1\Windows\System32\bthprops.cpl
```

14. Svcscan

This plugin is used to see the services are registered on your memory image, use the svcscan command. The output shows the process ID of each service the service name, service name, display name, service type, service state, and also shows the binary path for the registered service – which will be a .exe for user mode services and a driver name for services that run from kernel mode. To find the details on the services

```
volatility -f ram.mem --profile=Win7SP1x64 svcscan
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 svcscan

Offset: 0xcc8500
Order: 70
Start: SERVICE_AUTO_START
Process ID: 800
Service Name: Dhcp
Display Name: DHCP Client
Service Type: SERVICE_WIN32_SHARE_PROCESS
Service State: SERVICE_RUNNING
Binary Path: C:\Windows\System32\svchost.exe -k LocalServiceNetworkRestri
```

15. Cmdscan

This plugin searches the memory dump of XP/2003/Vista/2008 and Windows 7 for commands that the attacker might have entered through a command prompt (cmd.exe). It is one of the most powerful commands that one can use to gain visibility into an attacker's actions on a victim system. To conduct a cmdscan, you can make use of the following command:

```
volatility -f ram.mem --profile=Win7SP1x64 cmdscan
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 cmdscan
Volatility Foundation Volatility Framework 2.6
*****
CommandProcess: conhost.exe Pid: 2840
CommandHistory: 0x1e8ce0 Application: RamCapture64.exe Flags: Allocated
CommandCount: 0 LastAdded: -1 LastDisplayed: -1
FirstCommand: 0 CommandCountMax: 50
ProcessHandle: 0x64
Cmd #15 @ 0x180158:
Cmd #16 @ 0x1e7e50:
root@kali:~#
```

16. Iehistory

This plugin recovers the fragments of Internet Explorer history by finding index.dat cache file. To find iehistory files, you can type the following command:

```
volatility -f ram.mem --profile=Win7SP1x64 iehistory
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 iehistory
Volatility Foundation Volatility Framework 2.6
*****
Process: 2592 explorer.exe
Cache type "URL " at 0x2955100
Record length: 0x100
Location: Visited: raj@file:///C:/Users/raj/Desktop/New%20Text%20Document.txt
Last modified: 2020-10-01 16:26:04 UTC+0000
Last accessed: 2020-10-01 16:26:04 UTC+0000
File Offset: 0x100, Data Offset: 0x0, Data Length: 0xac
*****
Process: 2592 explorer.exe
Cache type "URL " at 0x2955200
Record length: 0x100
Location: Visited: raj@file:///C:/Users/raj/Desktop/Confidential.txt
Last modified: 2020-09-26 11:42:11 UTC+0000
Last accessed: 2020-09-26 11:42:11 UTC+0000
File Offset: 0x100, Data Offset: 0x0, Data Length: 0xa4
```

17. Dumpregistry

This plugin allows one to dump a registry hive into a disk location. To dump the registry hive, you use the following command.

```
volatility -f ram.mem --profile=Win7SP1x64 dumpregistry --dump-dir /root/ramdump/
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 dumpregistry --dump-dir /root/ramdump/
Volatility Foundation Volatility Framework 2.6
*****
Writing out registry: registry.0xfffff8a000024010.SYSTEM.reg

*****
Writing out registry: registry.0xfffff8a0015d7010.ntuserdat.reg

*****
Writing out registry: registry.0xfffff8a000eef010.NTUSERDAT.reg

*****
Writing out registry: registry.0xfffff8a00058f010.DEFAULT.reg

Physical layer returned None for index 23000, filling with NULL
*****
Writing out registry: registry.0xfffff8a00058a010.SECURITY.reg

*****
Writing out registry: registry.0xfffff8a0005ff010.SAM.reg
```

18. Moddump

This plugin is used to extract a kernel driver to a file, you can do this by using the following command:

```
volatility -f ram.mem --profile=Win7SP1x64 moddump --dump-dir /root/ramdump/
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 moddump --dump-dir /root/ramdump/
Volatility Foundation Volatility Framework 2.6
Module Base      Module Name      Result
-----
0xfffff80002a0b000 ntoskrnl.exe     OK: driver.fffff80002a0b000.sys
0xfffff80002ff5000 hal.dll           OK: driver.fffff80002ff5000.sys
0xfffff880017d9000 VIDEOPRT.SYS     OK: driver.fffff880017d9000.sys
0xfffff88004a8e000 ksthunk.sys      OK: driver.fffff88004a8e000.sys
0xfffff88004000000 dfsc.sys         OK: driver.fffff88004000000.sys
0xfffff88001aba000 vmstorfl.sys     OK: driver.fffff88001aba000.sys
0xfffff88004570000 rdpbus.sys       OK: driver.fffff88004570000.sys
0xfffff8800169b000 rdpencdd.sys     OK: driver.fffff8800169b000.sys
0xfffff88004adc000 usbccgp.sys    OK: driver.fffff88004adc000.sys
0xfffff88000eee000 WDFLDR.SYS      OK: driver.fffff88000eee000.sys
0xfffff88000f5d000 msisadrv.sys     OK: driver.fffff88000f5d000.sys
```


19. Procdump

This plugin is used to dump the executable processes in a single location, If there is malware present it will intentionally forge size fields in the PE header for the memory dumping tool to fail. To collect the dump on processes, you can type:

```
volatility -f ram.mem --profile=Win7SP1x64 procdump --dump-dir /root/ramdump/
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 procdump --dump-dir /root/ramdump/
Volatility Foundation Volatility Framework 2.6
Process(V)      ImageBase      Name           Result
-----
0xfffffa8030ece890 0x0000000047850000 System        Error: PEB at 0x0 is unavailable (possib
0xfffffa80318a02f0 0x0000000047850000 smss.exe      OK: executable.268.exe
0xfffffa8032104060 0x000000004a520000 csrss.exe     OK: executable.352.exe
0xfffffa80322d82f0 0x000000004a520000 csrss.exe     OK: executable.408.exe
0xfffffa80322d2a90 0x00000000ffbc0000 wininit.exe   OK: executable.416.exe
0xfffffa8032312060 0x00000000ffbe0000 winlogon.exe  OK: executable.464.exe
0xfffffa8032332780 0x00000000ff4e0000 services.exe  OK: executable.512.exe
0xfffffa8032368450 0x00000000ff310000 lsass.exe     OK: executable.520.exe
```

20. Memdump

The memdump plugin is used to dump the memory-resident pages of a process into a separate file. You can also lookup a particular process using -p and provide it with a directory path -D to generate the output. To take a dump on memory-resident pages, you can use the following command:

```
volatility -f ram.mem --profile=Win7SP1x64 memdump --dump-dir /root/ramdump/
```

```
root@kali:~# volatility -f ram.mem --profile=Win7SP1x64 memdump --dump-dir /root/ramdump/
Volatility Foundation Volatility Framework 2.6
*****
Writing System [ 4] to 4.dmp
*****
Writing smss.exe [ 268] to 268.dmp
*****
Writing csrss.exe [ 352] to 352.dmp
*****
```

21. Notepad

Notepad files are usually highly looked up files in the ram dump. To find the contents present in the notepad file, you can use the following command:

```
volatility -f ram.mem --profile=Win7SP1x64 notepad
```

```
root@kali:~# volatility -f ram.mem --profile=WinXPSP2x86 notepad
Volatility Foundation Volatility Framework 2.6
Process: 628
Text:
Thcgpune
Process: 1804
```

PassMark Volatility Workbench

Volatility Workbench is a GUI version of one of the most popular tool Volatility for analyzing the artifacts from a memory dump. It is available free of cost, open-source, and runs on the Windows Operating system. You can download it from [Here](#).

Features of Volatility Workbench

1. A forensic investigator does not have to worry about remembering the parameters of the command line.
2. It has made it easier to store dump information to a file on disk.
3. There is a drop-down list that contains the commands and its brief description.
4. It records the time stamp of the commands that were previously executed.

Download the tool and run it. Now choose the dump file that you have previously created and select the profile of the image that was created which could be used in place of imageinfo command. Now click on Refresh Process List and you can run all the commands.

1. Hunting rootkits and malicious code

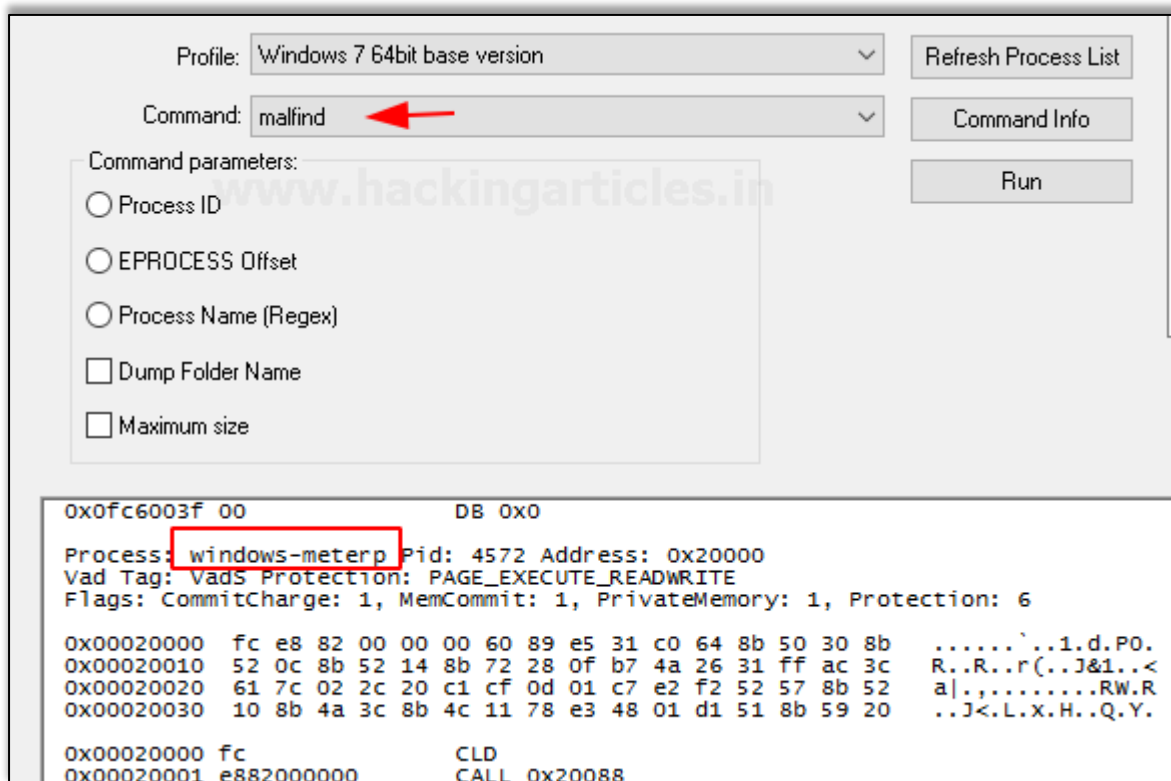
It tends to run a scan on the memory dump and looks around for the presence of a rootkit or a malicious code that would not be easily seen in the system but could be running in the background.

The screenshot shows the PassMark Volatility Workbench interface. The 'Image file' field is set to 'C:\Users\raj\Desktop\20201015.mem'. The 'Profile' dropdown is set to 'Windows 7 64bit base version'. The 'Command' dropdown is set to '-- Hunting rootkits and malicious code --'. The 'Refresh Process List' button is highlighted with a red box. The 'Command Description' panel on the right lists steps for running a command. The process list table below shows the following data:

Offset (V)	Name	PID	PPID	Thds	Hnds	Sess	Wow64	Start
0xfffffa8018dc4040	System	4	0	92	565	-----	0	2020-10-
14 20:55:37 UTC+0000								
0xfffffa8019463950	smss.exe	256	4	2	30	-----	0	2020-10-
14 20:55:37 UTC+0000								
0xfffffa8019f0c060	smss.exe	332	256	0	-----	0	0	2020-10-14
14 20:55:38 UTC+0000								
0xfffffa8019ff54a0	csrss.exe	352	332	9	469	0	0	2020-10-
14 20:55:38 UTC+0000								
0xfffffa801a191b30	smss.exe	396	256	0	-----	1	0	2020-10-14
14 20:55:38 UTC+0000								
0xfffffa801a1944d0	wininit.exe	404	332	3	77	0	0	2020-10-
14 20:55:38 UTC+0000								
0xfffffa801a195060	csrss.exe	412	396	11	485	1	0	2020-10-
14 20:55:38 UTC+0000								
0xfffffa801a1e7060	winlogon.exe	468	396	5	119	1	0	2020-10-
14 20:55:38 UTC+0000								
0xfffffa801a223440	services.exe	508	404	8	221	0	0	2020-10-
14 20:55:38 UTC+0000								

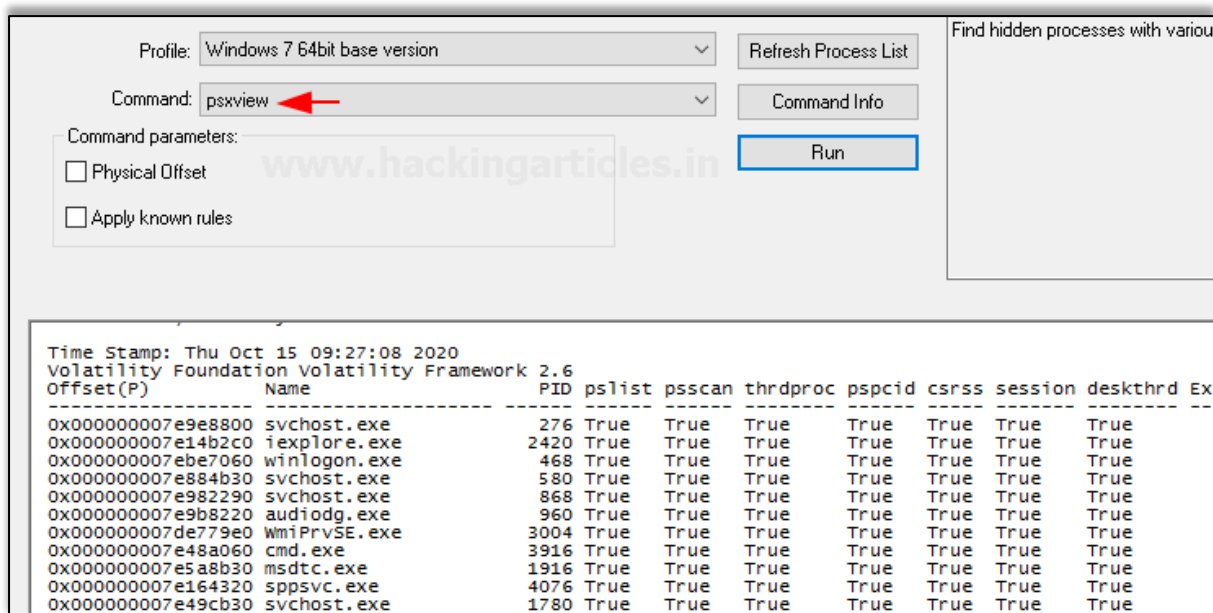
2. Malfind

It is a command which helps in finding a hidden code or a code that has been injected into the user's memory. It doesn't generally detect the presence of a DLL in a process but instead locates them.



3. psxview

This command usually helps in discovering any hidden processes in the plugin present in the memory dump.



4. Timers

It displays the timer of the kernel and all the associated timers present in the memory dump of the system.

Profile: Windows 7 64bit base version Refresh Process List

Command: timers Command Info

Command parameters:
☐ nt!KiTimer... Address

Run

Please wait, this may take a few minutes.

Time Stamp: Thu Oct 15 09:28:42 2020
 Volatility Foundation Volatility Framework 2.6

Offset(V)	DueTime	Period(ms)	Signaled	Routine	Module
0xffffffff80002c31b40	0x00003d36:0x9aa8bd43	0	-	0xffffffff80002b49340	ntoskrnl.exe
0xffffffff801914eb90	0x00000000:0xbbb133bd	0	Yes	0xffffffff80001453750	afd.sys
0xffffffff8019844000	0x00000000:0xbbd5f000	16	Yes	0xffffffff80003e4d9c0	vm3dmp.sys
0xffffffff80003d04480	0x00000002:0x1eff9180	0	-	0xffffffff80003d00c3c	dfsc.sys
0xffffffff80002c92fa0	0x00000000:0xb9f76c00	0	-	0xffffffff80002adb618	ntoskrnl.exe
0xffffffff880015185b0	0x00000000:0xb9f76c00	10000	Yes	0xffffffff880014b5360	cng.sys
0xffffffff880015185b0	0x00000000:0xb9f76c00	10000	Yes	0xffffffff880014b5360	cng.sys
0xffffffff880012b40e8	0x00000000:0xb9f76c00	0	-	0xffffffff88001272be0	Ntfs.sys
0xffffffff801a38c278	0x00000000:0xb9f76c00	0	-	0xffffffff88001718160	ndis.sys
0xffffffff801aa2a370	0x00000000:0xe765bde0	120000	Yes	0xffffffff80002b91390	ntoskrnl.exe
0xffffffff80197eb278	0x00000000:0xb9f76c00	0	-	0xffffffff88001718160	ndis.sys
0xffffffff80197ed278	0x00000000:0xb9f76c00	0	-	0xffffffff88001718160	ndis.sys

5. Getsids

This command can be used to view the Security Identifiers that are associated with a particular process. With the help of this command, you can identify if any malicious process has taken any privilege escalation.

Profile: Windows 7 64bit base version Refresh Process List

Command: getsids Command Info

Command parameters:
☐ Process ID
☐ EPROCESS Offset
☐ Process Name (Regex)

Run

Please wait, this may take a few minutes.

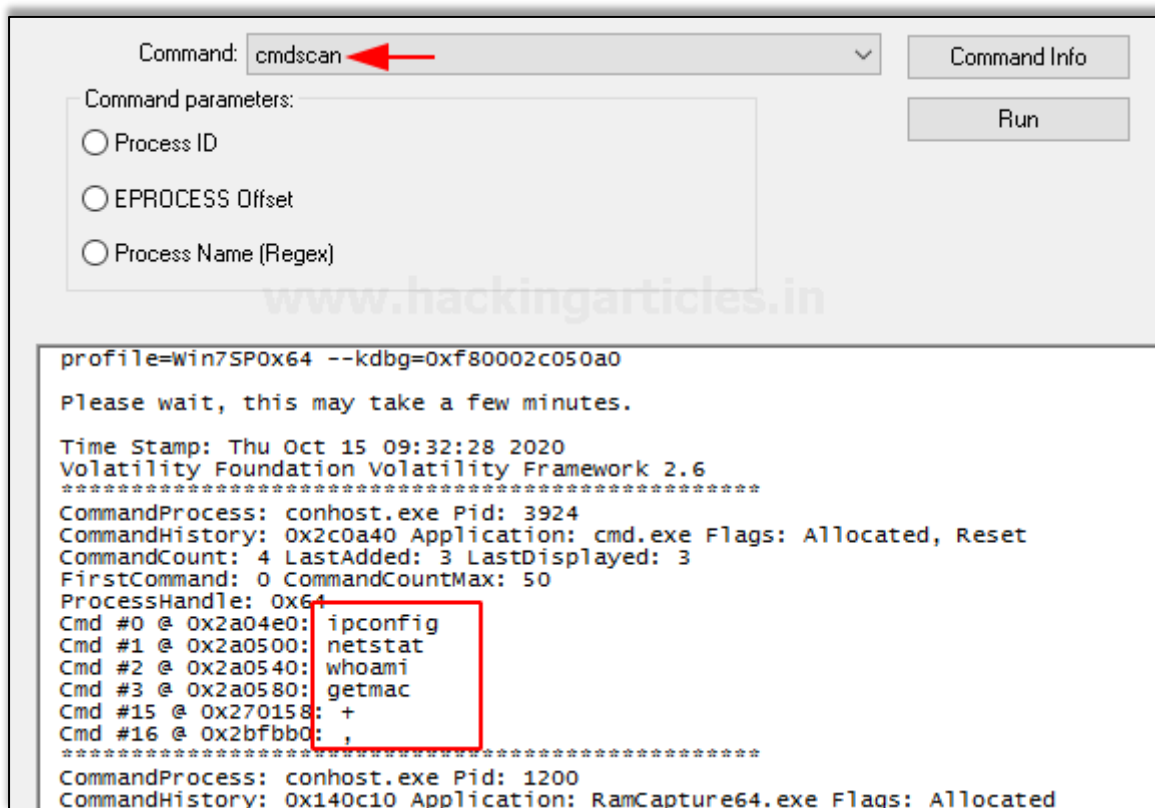
Time Stamp: Thu Oct 15 09:31:40 2020
 Volatility Foundation Volatility Framework 2.6

```

System (4): S-1-5-18 (Local System)
System (4): S-1-5-32-544 (Administrators)
System (4): S-1-1-0 (Everyone)
System (4): S-1-5-11 (Authenticated Users)
System (4): S-1-16-16384 (System Mandatory Level)
smss.exe (256): S-1-5-18 (Local System)
smss.exe (256): S-1-5-32-544 (Administrators)
smss.exe (256): S-1-1-0 (Everyone)
smss.exe (256): S-1-5-11 (Authenticated Users)
smss.exe (256): S-1-16-16384 (System Mandatory Level)
  
```

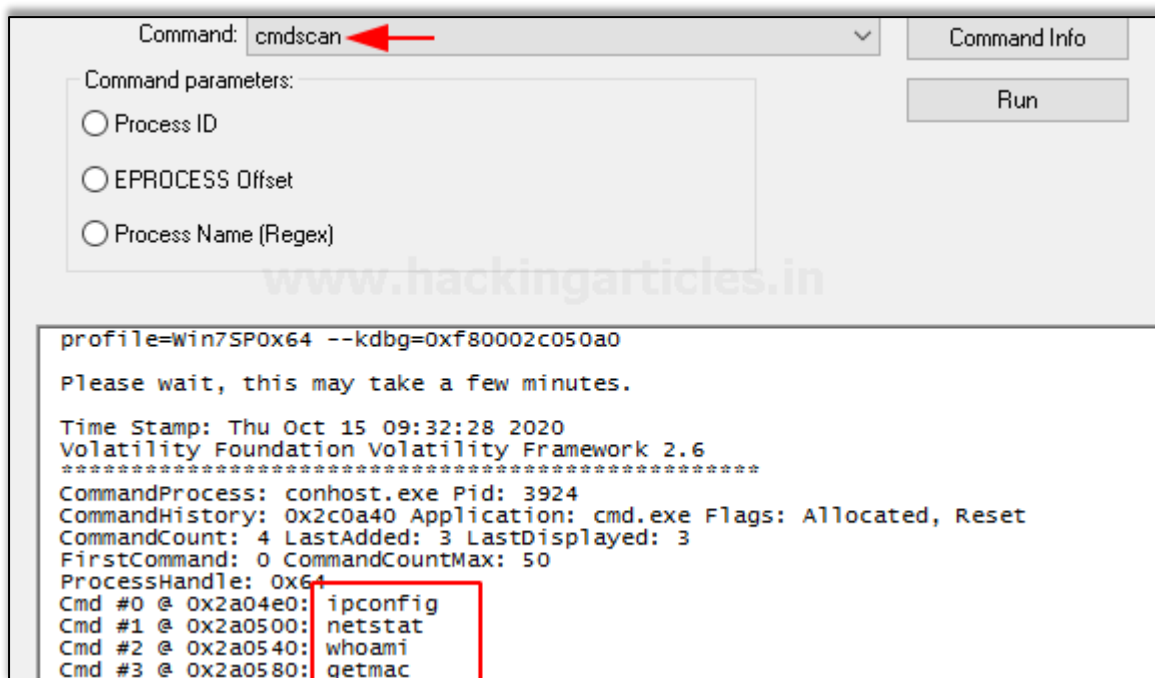
6. Cmdscan

This plugin helps in searching the memory dump for the command the user must have used the cmd.exe application. This command is highly used if the attacker's command activity is to be traced.



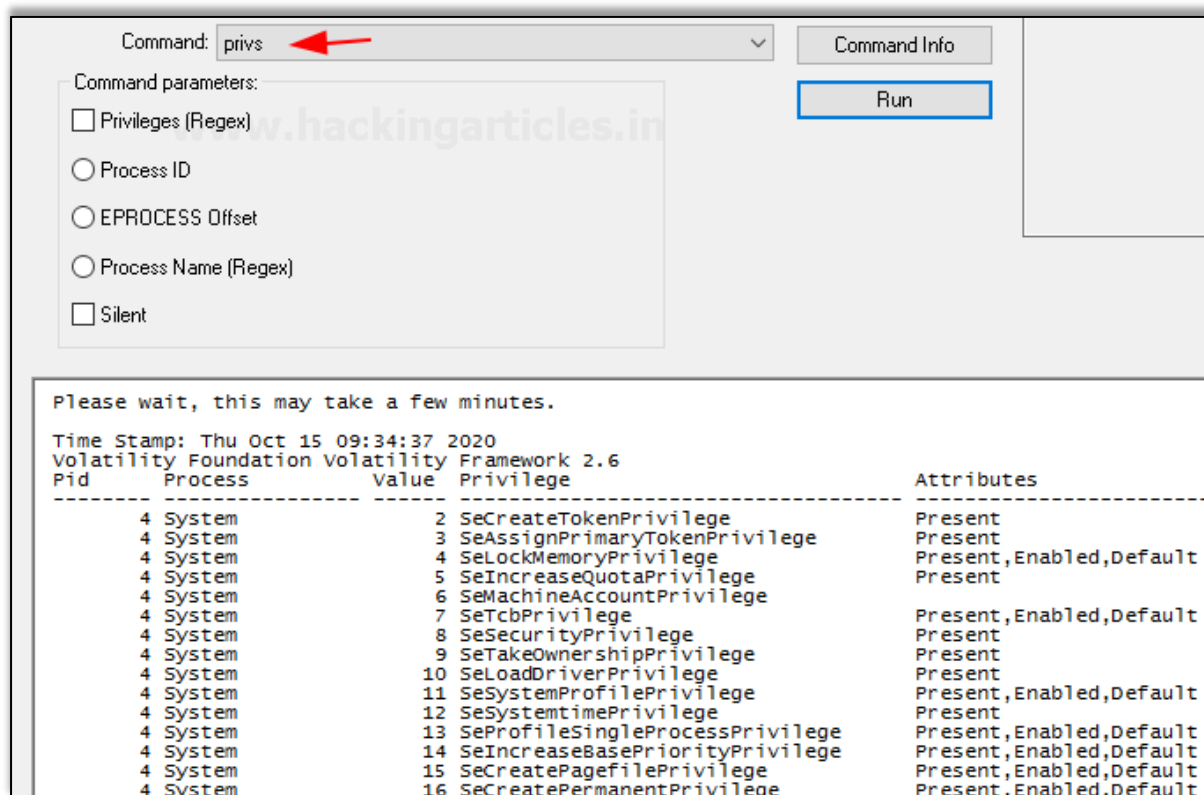
7. Consoles

This command is similar to cmdscan and helps to find if the attacker had typed anything in cmd or had executed anything via the backdoor.



8. Privs

This command displays the privileges assigned to the processes that are enabled or not enabled by default.



Command: **privs**

Command parameters:

- ☐ Privileges (Regex)
- ☐ Process ID
- ☐ EPROCESS Offset
- ☐ Process Name (Regex)
- ☐ Silent

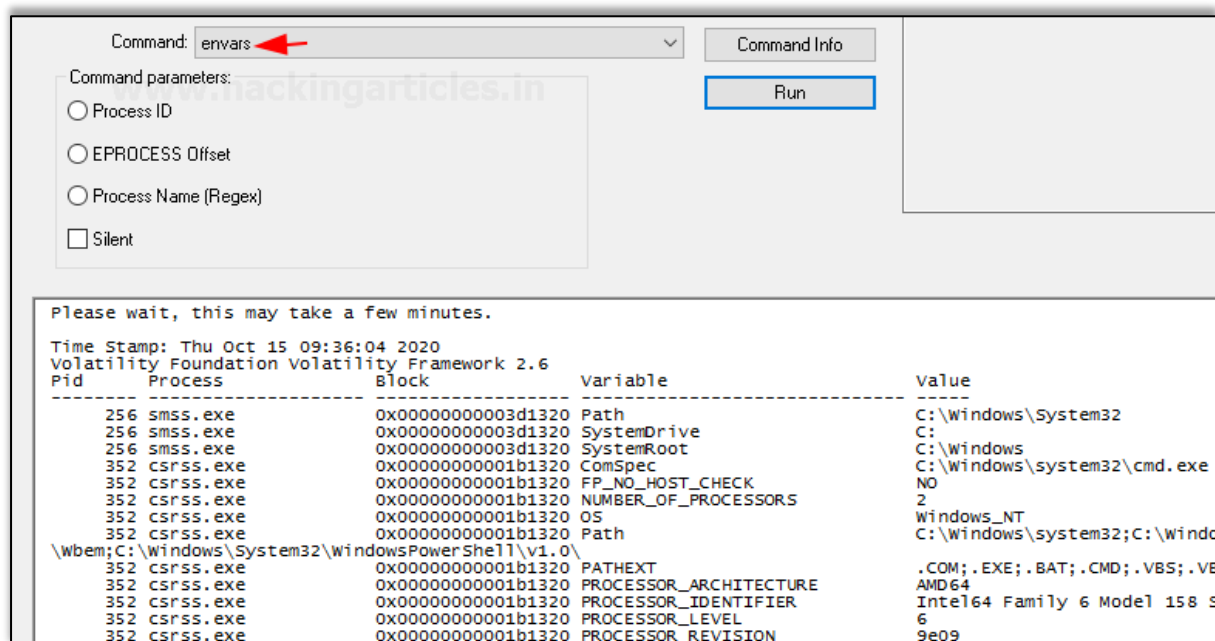
Please wait, this may take a few minutes.

Time Stamp: Thu Oct 15 09:34:37 2020
Volatility Foundation Volatility Framework 2.6

Pid	Process	Value	Privilege	Attributes
4	System	2	SeCreateTokenPrivilege	Present
4	System	3	SeAssignPrimaryTokenPrivilege	Present
4	System	4	SeLockMemoryPrivilege	Present, Enabled, Default
4	System	5	SeIncreaseQuotaPrivilege	Present
4	System	6	SeMachineAccountPrivilege	
4	System	7	SeTcbPrivilege	Present, Enabled, Default
4	System	8	SeSecurityPrivilege	Present
4	System	9	SeTakeOwnershipPrivilege	Present
4	System	10	SeLoadDriverPrivilege	Present
4	System	11	SeSystemProfilePrivilege	Present, Enabled, Default
4	System	12	SeSystemtimePrivilege	Present
4	System	13	SeProfileSingleProcessPrivilege	Present, Enabled, Default
4	System	14	SeIncreaseBasePriorityPrivilege	Present, Enabled, Default
4	System	15	SeCreatePagefilePrivilege	Present, Enabled, Default
4	System	16	SeCreatePermanentPrivilege	Present, Enabled, Default

9. Envars

This command displays all the variables in the process, its environment along with its current directory.



Command: **envvars**

Command parameters:

- ☐ Process ID
- ☐ EPROCESS Offset
- ☐ Process Name (Regex)
- ☐ Silent

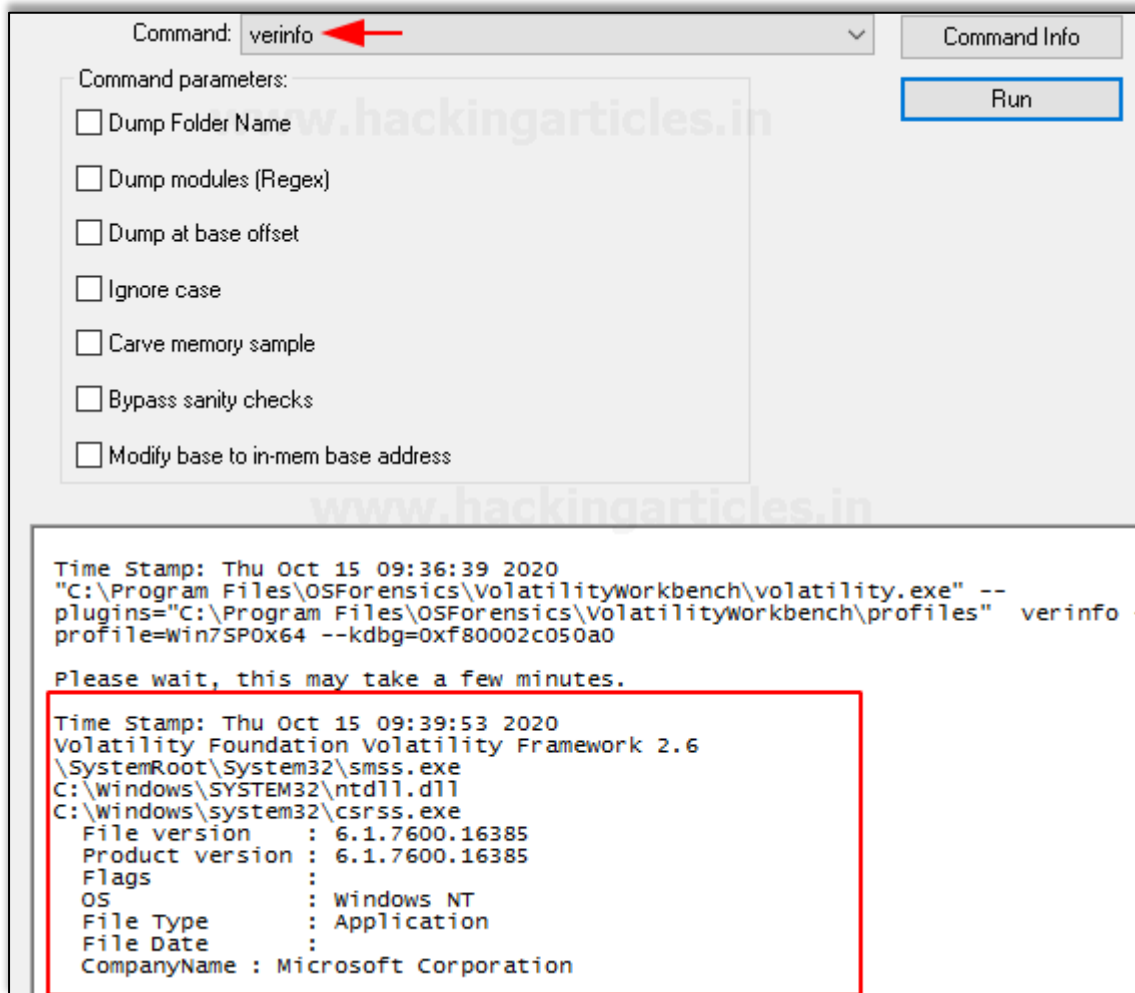
Please wait, this may take a few minutes.

Time Stamp: Thu Oct 15 09:36:04 2020
Volatility Foundation Volatility Framework 2.6

Pid	Process	Block	Variable	Value
256	smss.exe	0x000000000003d1320	Path	C:\Windows\System32
256	smss.exe	0x000000000003d1320	SystemDrive	C:
256	smss.exe	0x000000000003d1320	SystemRoot	C:\Windows
352	csrss.exe	0x000000000001b1320	ComSpec	C:\Windows\system32\cmd.exe
352	csrss.exe	0x000000000001b1320	FP_NO_HOST_CHECK	NO
352	csrss.exe	0x000000000001b1320	NUMBER_OF_PROCESSORS	2
352	csrss.exe	0x000000000001b1320	OS	Windows_NT
352	csrss.exe	0x000000000001b1320	Path	C:\Windows\system32;C:\Wind
352	csrss.exe	0x000000000001b1320	PATHEXT	.COM;.EXE;.BAT;.CMD;.VBS;.VB
352	csrss.exe	0x000000000001b1320	PROCESSOR_ARCHITECTURE	AMD64
352	csrss.exe	0x000000000001b1320	PROCESSOR_IDENTIFIER	Intel64 Family 6 Model 158 S
352	csrss.exe	0x000000000001b1320	PROCESSOR_LEVEL	6
352	csrss.exe	0x000000000001b1320	PROCESSOR_REVISION	9e09

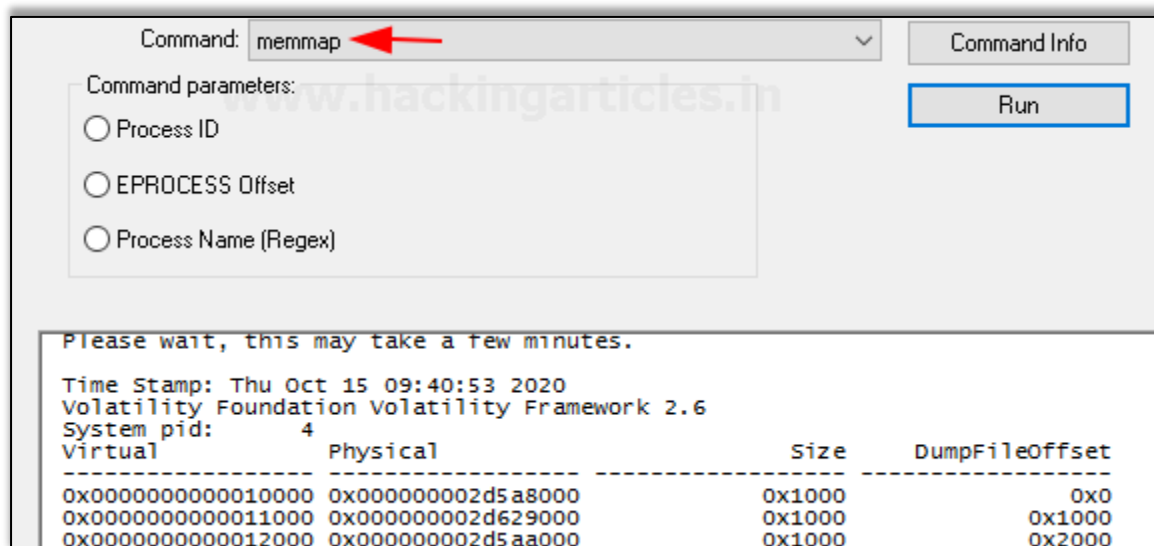
10. Verinfo


This command displays the version information that is present in the PE files. It helps identify any binaries and also correlates with other files.



11. Memmap

This command shows the exact pages that are present on the page of a specific process. It also shows the virtual address of the page and the size of its page.



Command: **memmap** 

Command parameters:

- ☐ Process ID
- ☐ EPROCESS Offset
- ☐ Process Name (Regex)

Run

Please wait, this may take a few minutes.

Time Stamp: Thu Oct 15 09:40:53 2020
Volatility Foundation Volatility Framework 2.6
System pid: 4

Virtual	Physical	Size	DumpFileOffset
0x0000000000010000	0x000000002d5a8000	0x1000	0x0
0x0000000000011000	0x000000002d629000	0x1000	0x1000
0x0000000000012000	0x000000002d5aa000	0x1000	0x2000

12. Vadinfo

This command usually displays information about a particular process's VAD nodes. It displays the VAD Flags control flags, VAD tags.

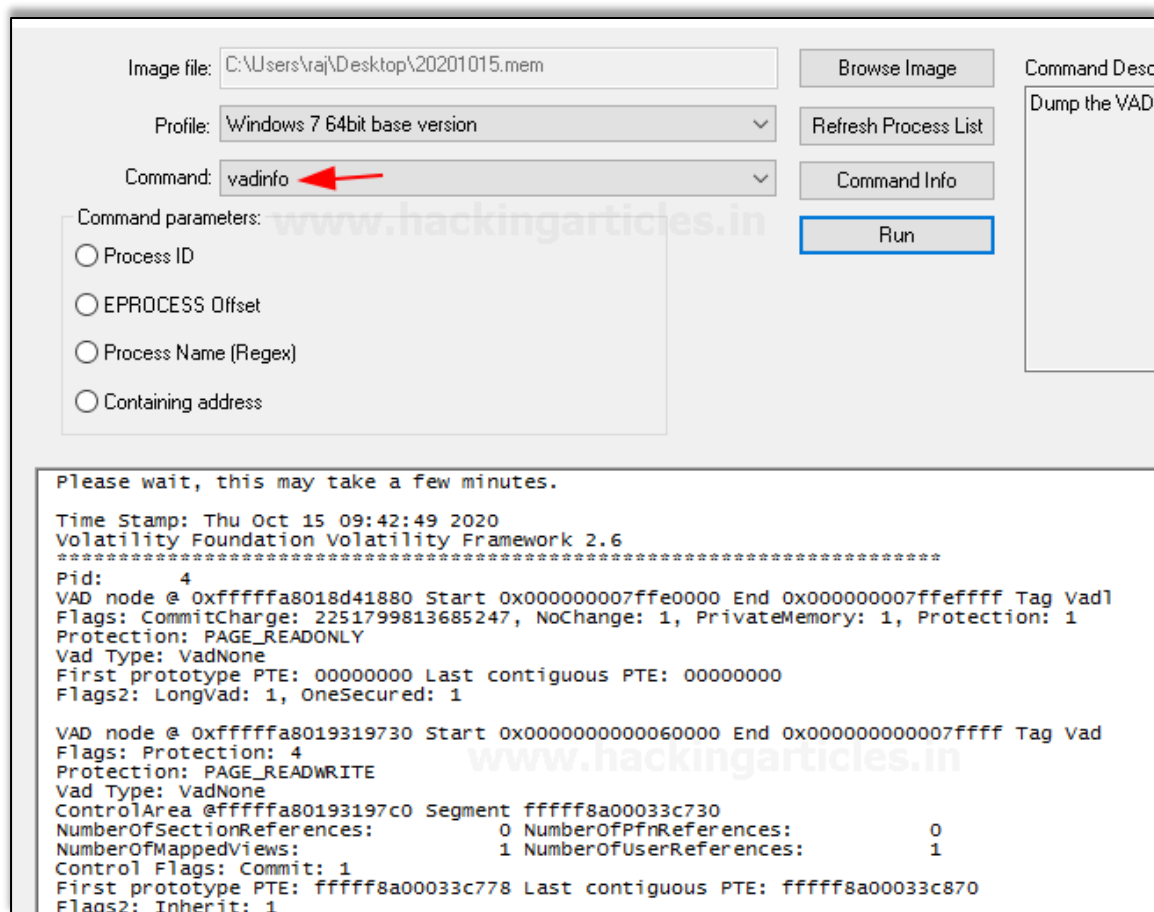



Image file: C:\Users\raj\Desktop\20201015.mem **Browse Image**

Profile: Windows 7 64bit base version **Refresh Process List**

Command: **vadinfo** 

Command parameters:

- ☐ Process ID
- ☐ EPROCESS Offset
- ☐ Process Name (Regex)
- ☐ Containing address

Run

Command Desc
Dump the VAD

Please wait, this may take a few minutes.

Time Stamp: Thu Oct 15 09:42:49 2020
Volatility Foundation Volatility Framework 2.6

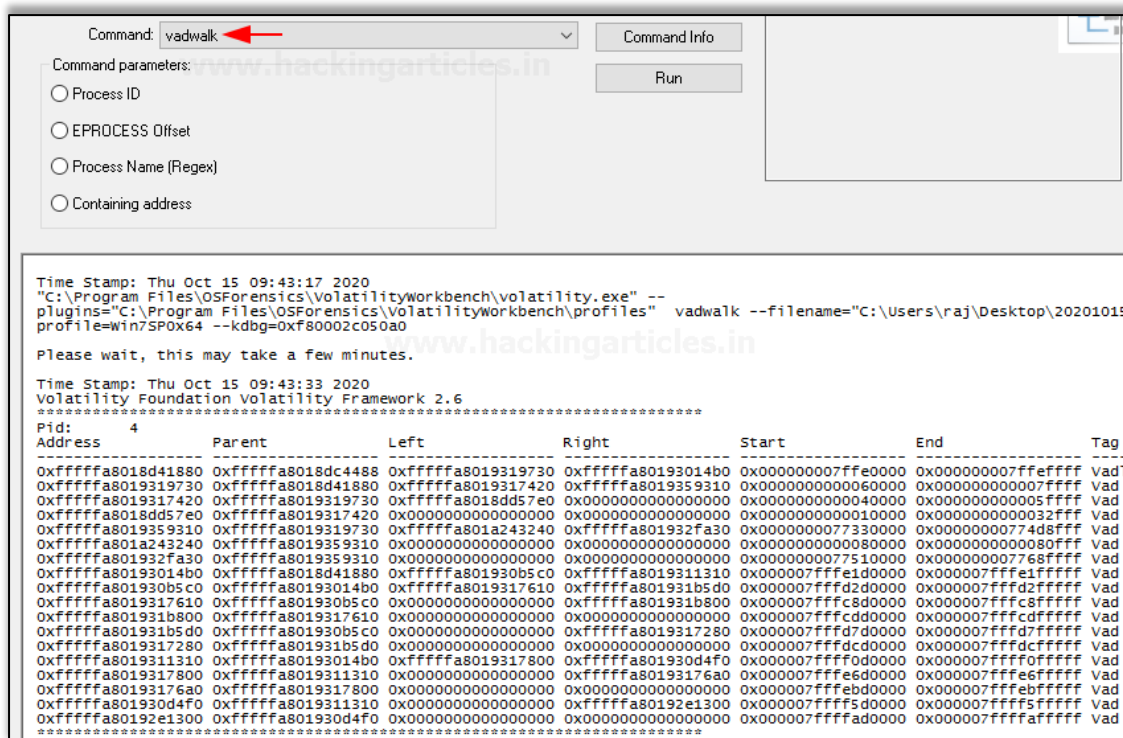
Pid: 4

VAD node @ 0xfffffa8018d41880 Start 0x000000007ffe0000 End 0x000000007ffeffff Tag Vad1
Flags: CommitCharge: 2251799813685247, NoChange: 1, PrivateMemory: 1, Protection: 1
Protection: PAGE_READONLY
Vad Type: VadNone
First prototype PTE: 00000000 Last contiguous PTE: 00000000
Flags2: LongVad: 1, OneSecured: 1

VAD node @ 0xfffffa8019319730 Start 0x0000000000600000 End 0x00000000007fffff Tag Vad
Flags: Protection: 4
Protection: PAGE_READWRITE
Vad Type: VadNone
ControlArea @fffffa80193197c0 Segment fffff8a00033c730
NumberOfSectionReferences: 0 NumberOfPfnReferences: 0
NumberOfMappedViews: 1 NumberOfUserReferences: 1
Control Flags: Commit: 1
First prototype PTE: fffff8a00033c778 Last contiguous PTE: fffff8a00033c870
Flags2: Inherit: 1

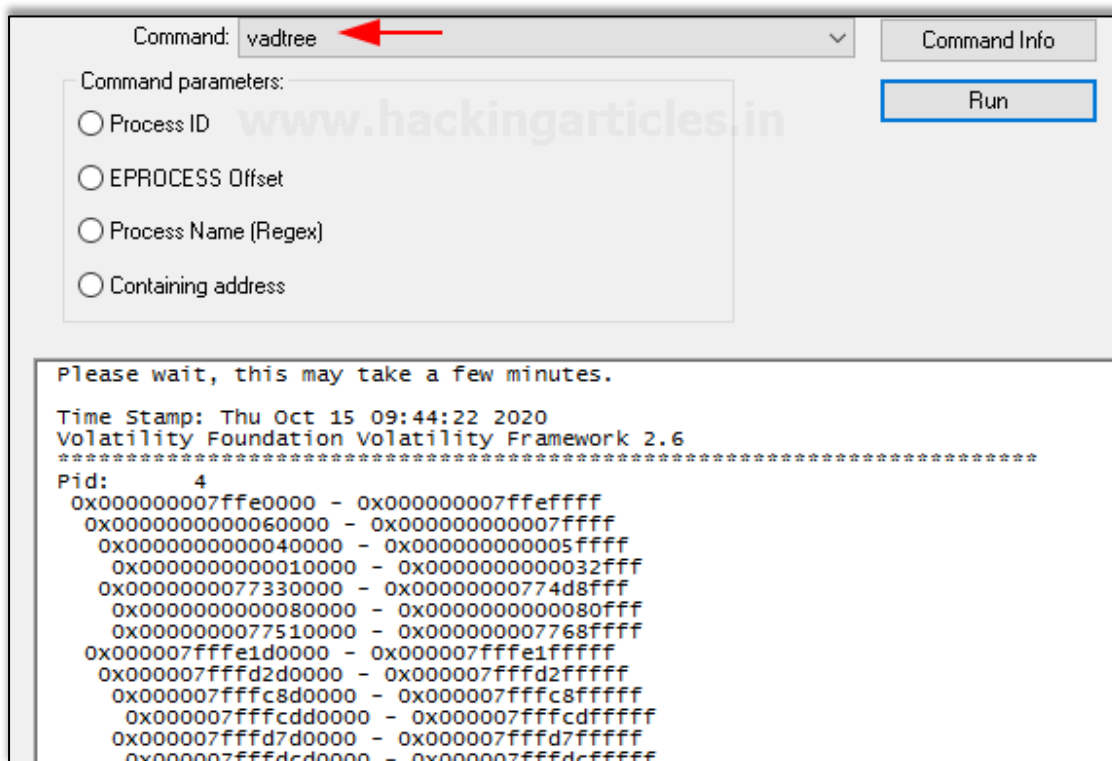
13. Vadwalk

It is a command that is used to display all the VAD nodes in a tabular form.



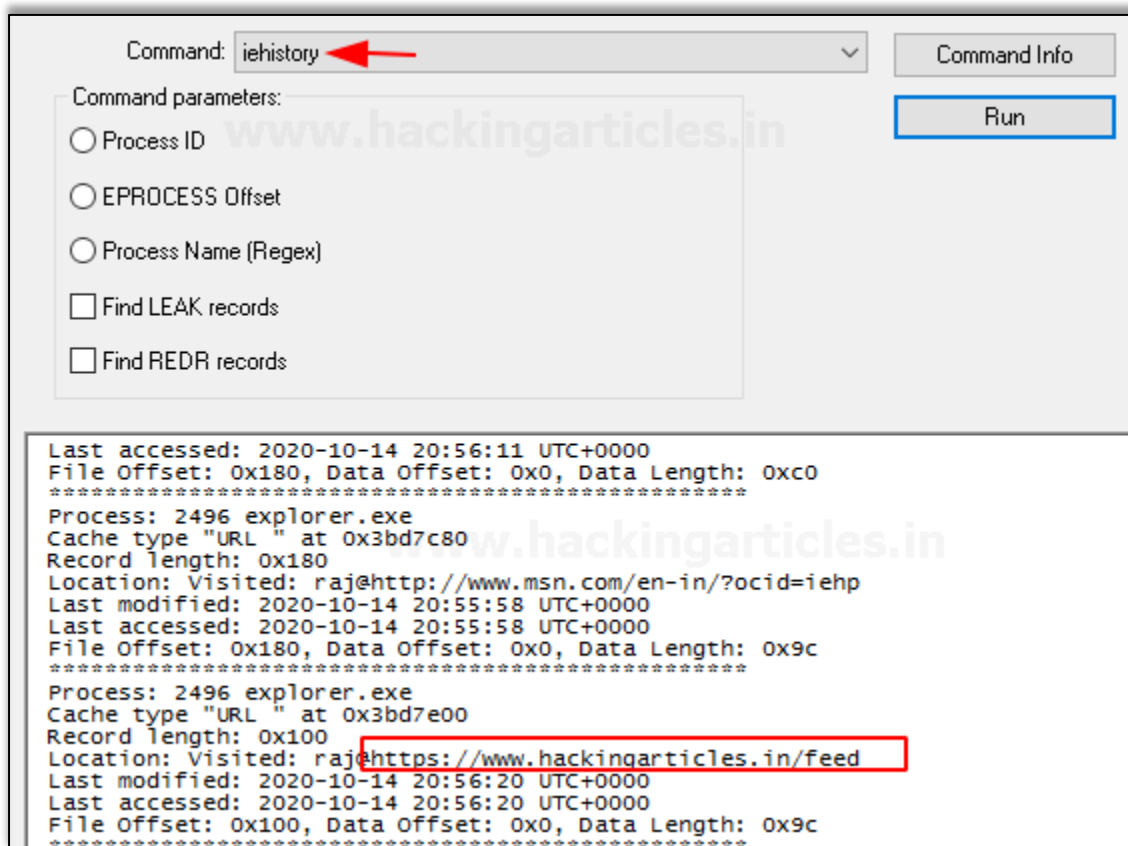
14. Vadtrees

This process displays the VAD nodes in a tree form.



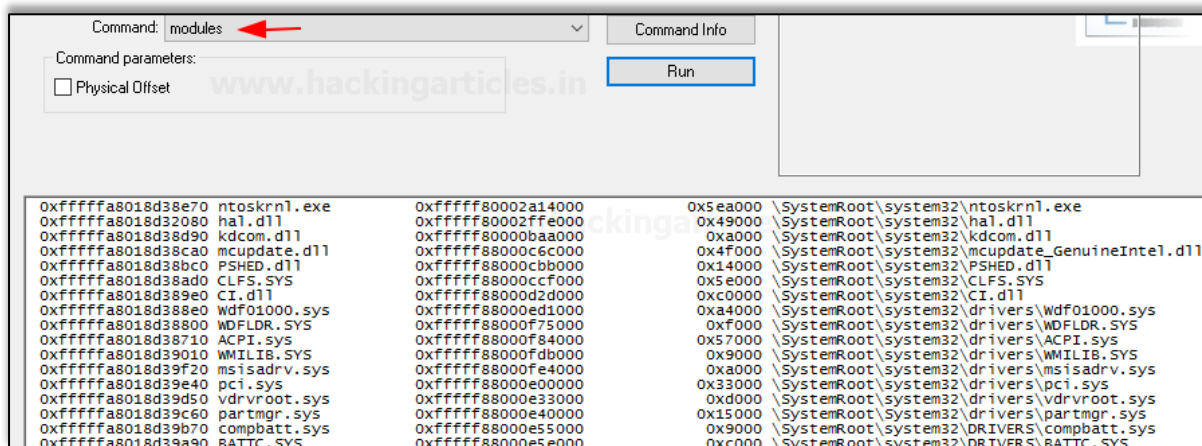
15. iehistory

This Plugin helps in recovering the fragments of the Internet explore history index.dat named cache files. It displays FTP and HTTP links that were accessed, links that were redirected, any deleted entries.



16. Modules

This command is used to list the kernel drivers that are present in the system.



17. SSDT

This command is used to list the functions present in the original and GUI SSDTs. It displays the index, the name of the function, and the owner of the driver of each entry in the SSDT.

Image file: C:\Users\raj\Desktop\20201015.mem
 Profile: Windows 7 64bit base version
 Command: ssdt

Command Description:
 Display SSDT entries

Run

Time Stamp: Thu Oct 15 09:49:00 2020
 Volatility Foundation Volatility Framework 2.6

Offset(P)	#Ptr	#Hnd	Start	Size	Service Key	Name	Driver Name
0x000000007d96c770	4	0	0xffffffff8000e55000	0x9000	Compbatt	Compbatt	\Driver\Compbatt
0x000000007d96c50	3	0	0xffffffff8000e33000	0xd000	vdrvroot	vdrvroot	\Driver\vdrvroot
0x000000007d973770	3	0	0xffffffff8000fe4000	0xa000	msisadrv	msisadrv	\Driver\msisadrv
0x000000007e434de0	3	0	0xffffffff8000522000	0x6b000	srv2	srv2	\FileSystem\srsv2
0x000000007e4f0b00	3	0	0xffffffff800082dd000	0x7000	RamCaptureDriver	RamCa...iver	\Driver\RamCaptureDriver
0x000000007e54d770	3	0	0xffffffff8000537e000	0xb000	TDTCP	TDTCP	\Driver\TDTCP
0x000000007e57e7d0	3	0	0xffffffff80005389000	0xf000	tssecsrv	tssecsrv	\Driver\tssecsrv
0x000000007e598060	3	0	0xffffffff80005398000	0x39000	RDPMO	RDPMO	\Driver\RDPMO
0x000000007e60c8f0	3	0	0xffffffff80002cf0000	0x15000	lltdio	lltdio	\Driver\lltdio
0x000000007e612390	3	0	0xffffffff80002d12000	0x18000	rspndr	rspndr	\Driver\rspndr
0x000000007e61c060	4	0	0xffffffff80002d2a000	0xc9000	HTTP	HTTP	\Driver\HTTP
0x000000007e70f6b0	3	0	0xffffffff80001b94000	0x1e000	bowser	bowser	\FileSystem\bowser
0x000000007e713610	3	0	0xffffffff80003fe7000	0x18000	mpsdrv	mpsdrv	\Driver\mpsdrv
0x000000007e7153d0	4	0	0xffffffff80003ad4000	0x2d000	mrxsm	mrxsm	\FileSystem\mrxsm
0x000000007e727a90	2	0	0xffffffff80003b01000	0x4d000	mrxsm	mrxsm	\FileSystem\mrxsm
0x000000007e759510	15	0	0xffffffff80003b7c000	0xc000	npf	npf	\Driver\npf
0x000000007e789df0	3	0	0xffffffff80003a00000	0xa6000	PEAUTH	PEAUTH	\Driver\PEAUTH
0x000000007e7a49c0	4	0	0xffffffff80003aa6000	0xb000	secdrv	secdrv	\Driver\secdrv
0x000000007e7ca8a0	3	0	0xffffffff8000528b000	0x99000	srv	srv	\FileSystem\srsv
0x000000007e7ed7d0	4	0	0xffffffff80005324000	0x2c000	vmhgs	vmhgs	\FileSystem\vmhgs
0x000000007e8a0870	3	0	0xffffffff8000443d000	0x9000	vmusbmouse	vmusbmouse	\Driver\vmusbmouse
0x000000007e8e4470	2	0	0xffffffff80003e00000	0x23000	luafl	luafl	\FileSystem\luafl
0x000000007e907c70	6	0	0xffffffff80003e23000	0x18000	STHUSB	STHUSB	\Driver\STHUSB
0x000000007e936060	22	0	0xffffffff80005350000	0x2e000	RDPMO	RDPMO	\Driver\RDPMO
0x000000007e974e70	4	0	0xffffffff80002cc0000	0x10000	BthEnum	BthEnum	\Driver\BthEnum
0x000000007e986850	4	0	0xffffffff80002cdd000	0x20000	BthPan	BthPan	\Driver\BthPan
0x000000007e9de3b0	2	0	0xffffffff80003bb9000	0x12000	tcpipreg	tcpipreg	\Driver\tcpipreg
0x000000007e9fd060	4	0	0xffffffff80003b88000	0x31000	srsvnet	srsvnet	\FileSystem\srsvnet
0x000000007eb90780	6	0	0xffffffff80004400000	0xe000	Hidusb	Hidusb	\Driver\Hidusb
0x000000007eba3bc0	3	0	0xffffffff80003b72000	0xa000	VMMemCt1	VMMemCt1	\Driver\VMMemCt1
0x000000007ebdbd70	4	0	0xffffffff80004430000	0xd000	mouhid	mouhid	\Driver\mouhid
0x000000007ebf0d60	4	0	0xffffffff80002ca1000	0x2c000	RFCOMM	RFCOMM	\Driver\RFCOMM
0x000000007ed4ee70	3	0	0xffffffff800044a0000	0x15000	NDProxy	NDProxy	\Driver\NDProxy
0x000000007eds9860	3	0	0xffffffff800044b5000	0x5c000	HdAudAddService	HdAud...vice	\Driver\HdAudAddService
0x000000007ed64e70	3	0	0xffffffff80004570000	0x5200	ksthunk	ksthunk	\Driver\ksthunk
0x000000007ede3a50	5	0	0xffffffff800045d8000	0x1d000	usbccgp	usbccgp	\Driver\usbccgp
0x000000007edf44a0	14	0	0xffffffff96000070000	0x0	\Driver\Win32k	Win32k	\Driver\Win32k

18. Driverscan

This command can be used to find the DRIVER_OBJECT present in the physical memory by making use of a pool tag scan.

Command: driverscan

Command parameters:
☐ Start scanning address
☐ Length (in bytes)
☐ Scan virtual space
☐ Skip unalloc objects

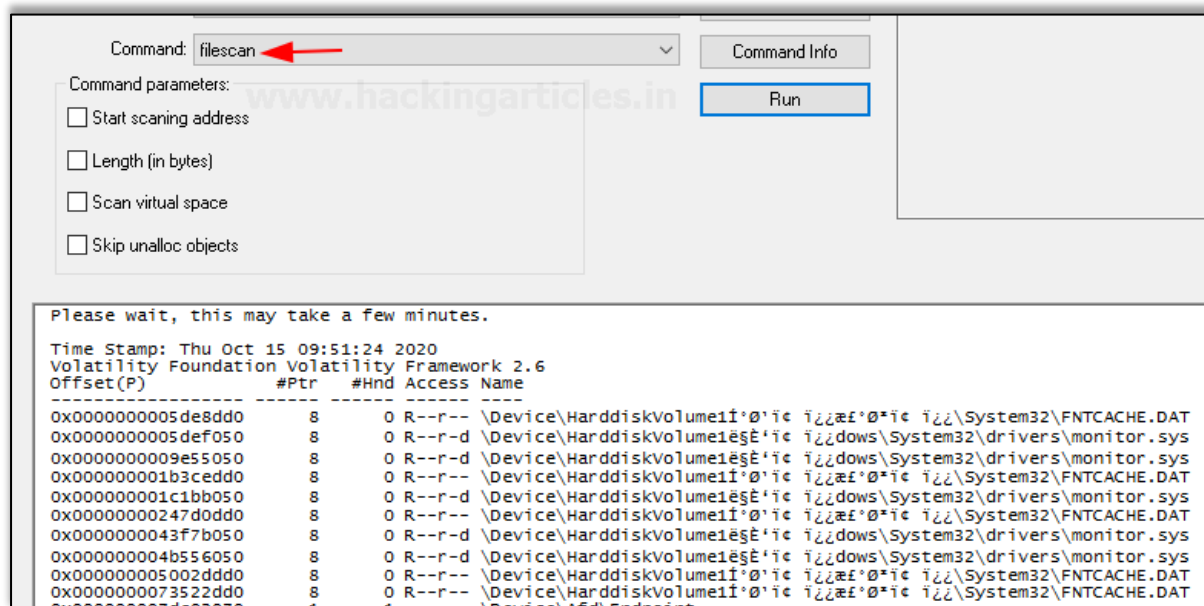
Run

Volatility Foundation Volatility Framework 2.6

Offset(P)	#Ptr	#Hnd	Start	Size	Service Key	Name	Driver Name
0x000000007d96c770	4	0	0xffffffff8000e55000	0x9000	Compbatt	Compbatt	\Driver\Compbatt
0x000000007d96c50	3	0	0xffffffff8000e33000	0xd000	vdrvroot	vdrvroot	\Driver\vdrvroot
0x000000007d973770	3	0	0xffffffff8000fe4000	0xa000	msisadrv	msisadrv	\Driver\msisadrv
0x000000007e434de0	3	0	0xffffffff8000522000	0x6b000	srv2	srv2	\FileSystem\srsv2
0x000000007e4f0b00	3	0	0xffffffff800082dd000	0x7000	RamCaptureDriver	RamCa...iver	\Driver\RamCaptureDriver
0x000000007e54d770	3	0	0xffffffff8000537e000	0xb000	TDTCP	TDTCP	\Driver\TDTCP
0x000000007e57e7d0	3	0	0xffffffff80005389000	0xf000	tssecsrv	tssecsrv	\Driver\tssecsrv
0x000000007e598060	3	0	0xffffffff80005398000	0x39000	RDPMO	RDPMO	\Driver\RDPMO
0x000000007e60c8f0	3	0	0xffffffff80002cf0000	0x15000	lltdio	lltdio	\Driver\lltdio
0x000000007e612390	3	0	0xffffffff80002d12000	0x18000	rspndr	rspndr	\Driver\rspndr
0x000000007e61c060	4	0	0xffffffff80002d2a000	0xc9000	HTTP	HTTP	\Driver\HTTP
0x000000007e70f6b0	3	0	0xffffffff80001b94000	0x1e000	bowser	bowser	\FileSystem\bowser
0x000000007e713610	3	0	0xffffffff80003fe7000	0x18000	mpsdrv	mpsdrv	\Driver\mpsdrv
0x000000007e7153d0	4	0	0xffffffff80003ad4000	0x2d000	mrxsm	mrxsm	\FileSystem\mrxsm
0x000000007e727a90	2	0	0xffffffff80003b01000	0x4d000	mrxsm	mrxsm	\FileSystem\mrxsm
0x000000007e759510	15	0	0xffffffff80003b7c000	0xc000	npf	npf	\Driver\npf
0x000000007e789df0	3	0	0xffffffff80003a00000	0xa6000	PEAUTH	PEAUTH	\Driver\PEAUTH
0x000000007e7a49c0	4	0	0xffffffff80003aa6000	0xb000	secdrv	secdrv	\Driver\secdrv
0x000000007e7ca8a0	3	0	0xffffffff8000528b000	0x99000	srv	srv	\FileSystem\srsv
0x000000007e7ed7d0	4	0	0xffffffff80005324000	0x2c000	vmhgs	vmhgs	\FileSystem\vmhgs

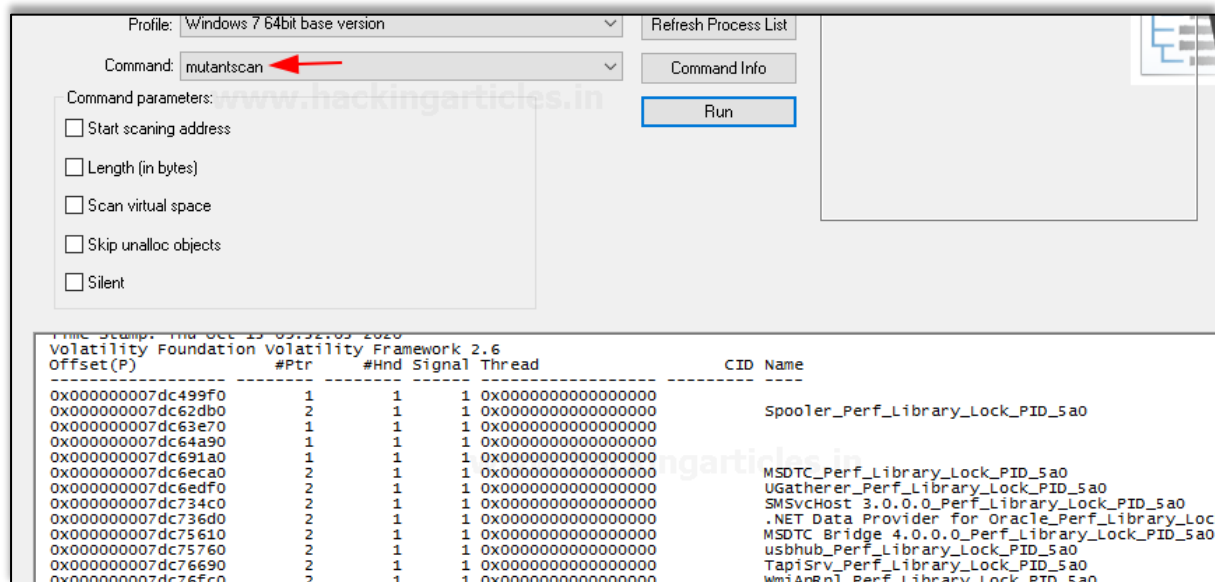
19. File Scan

This command can be used to find File_object that is present in the physical memory by making use of a pool tag scan. This command will help in finding open files in the system dump even if they are hidden with the help of rootkit.



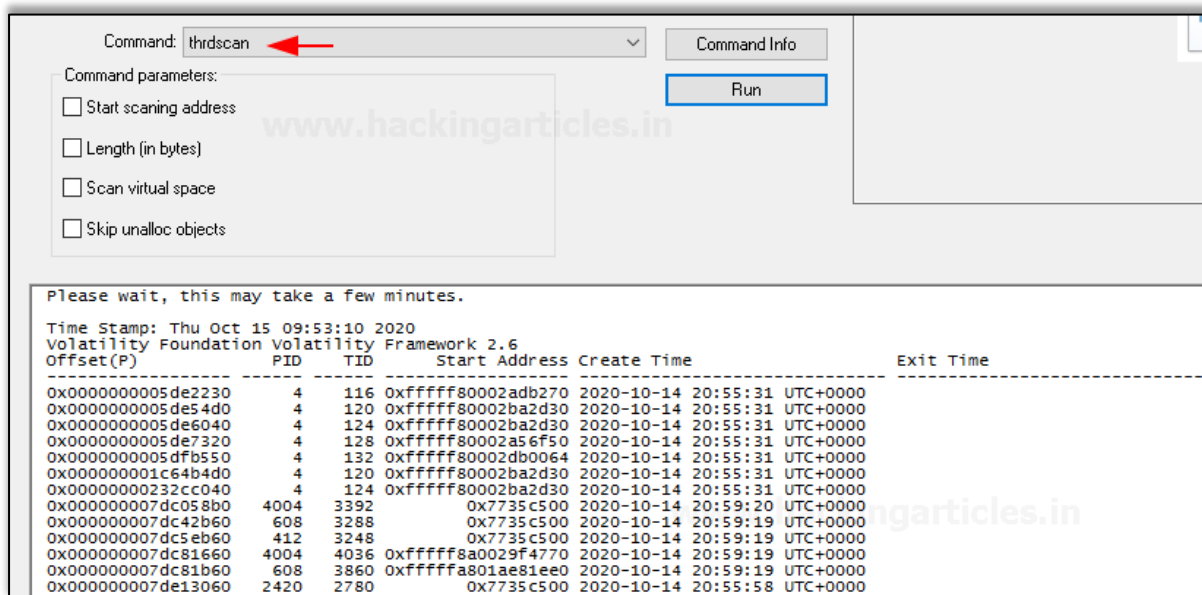
20. Mutant scan

This command is used to scan the physical memory of mutant objects by making use of pool tag scanning.



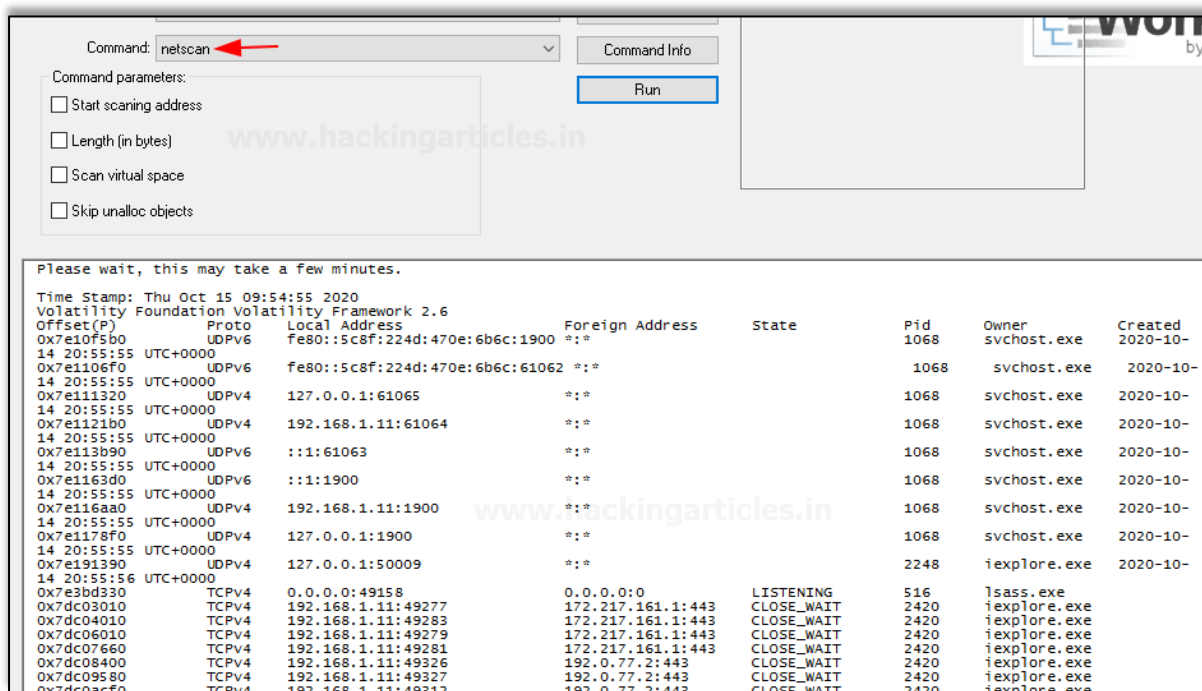
21. Thrdscan

This command is used to find the thread objects that are present in the physical memory with the help of a pool tag scan. It contains certain fields that can identify its parent processes which can help in finding hidden processes.



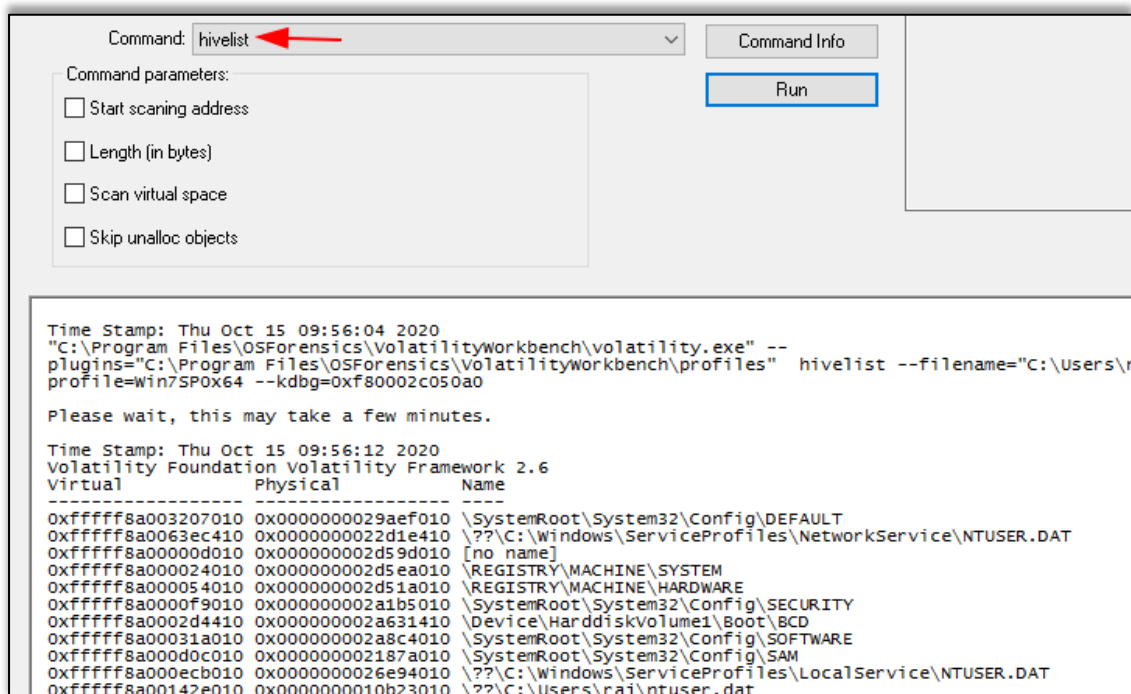
22. Netscan

This plugin helps in finding network-related artefacts present in the memory dump. It makes use of pool tag scanning. This plugin finds all the TCP endpoints, TCP listeners, UDP endpoints, and UDP listeners. It provides details about the local and remote IP and also about the local and remote port



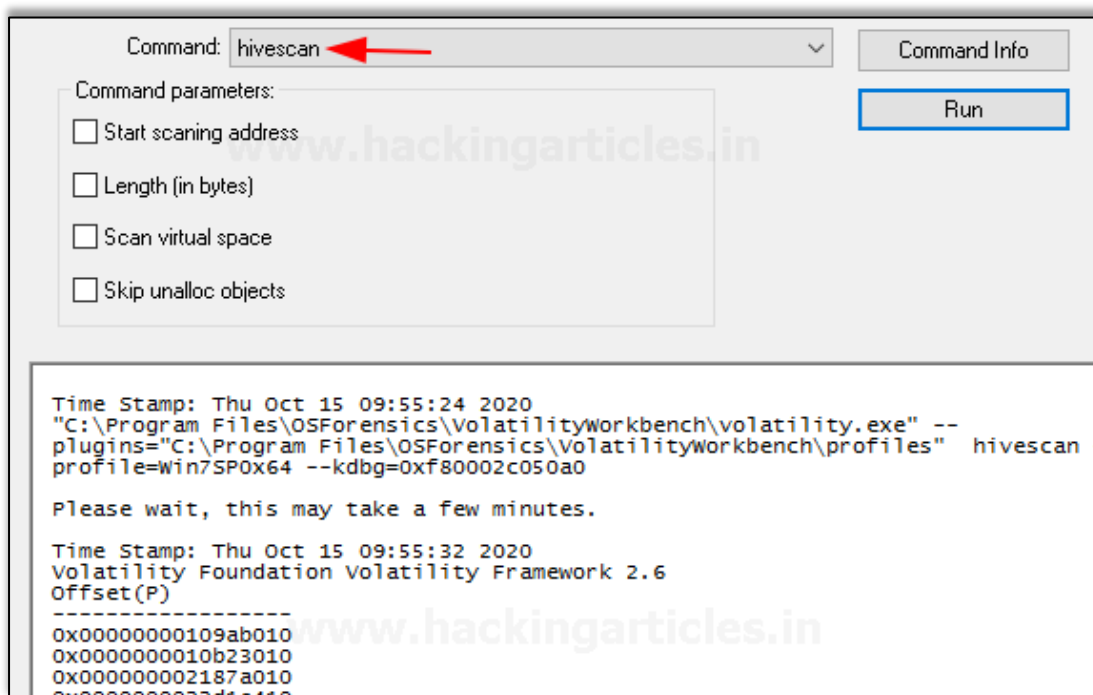
23. Hivelist

This command can be used to locate the virtual addresses present in the registry hives in memory, and their entire paths to hive on the disk.



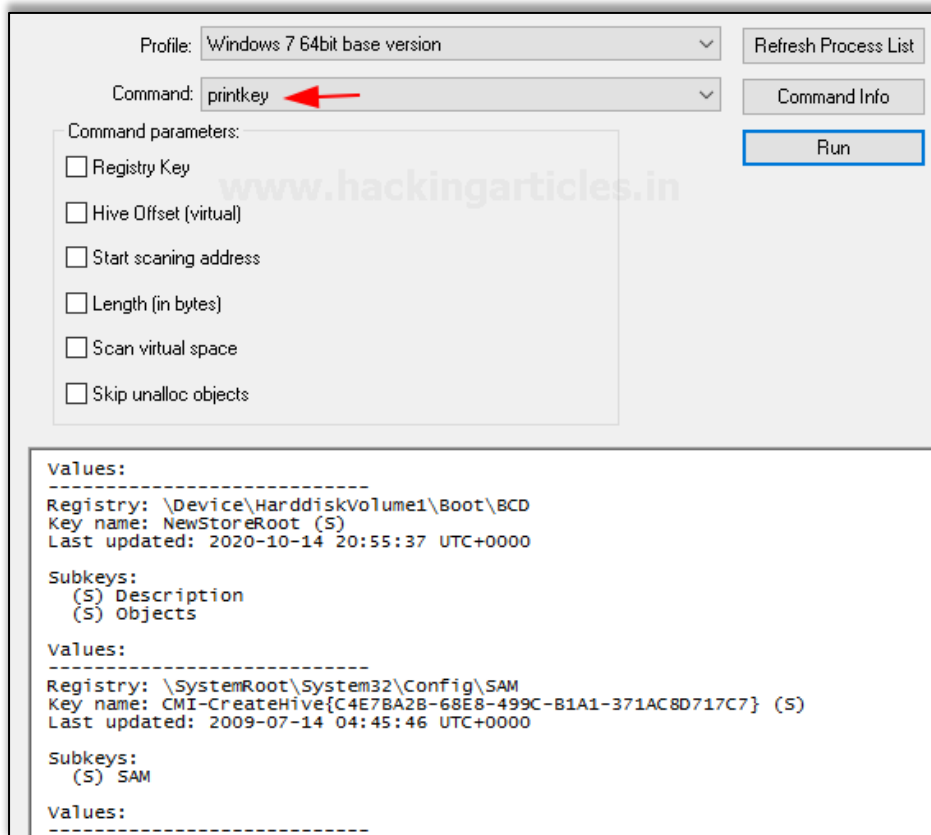
24. Hivescan

This command is used to find the physical address of the registry hives that are present in the memory. It is there to support the hivelist.



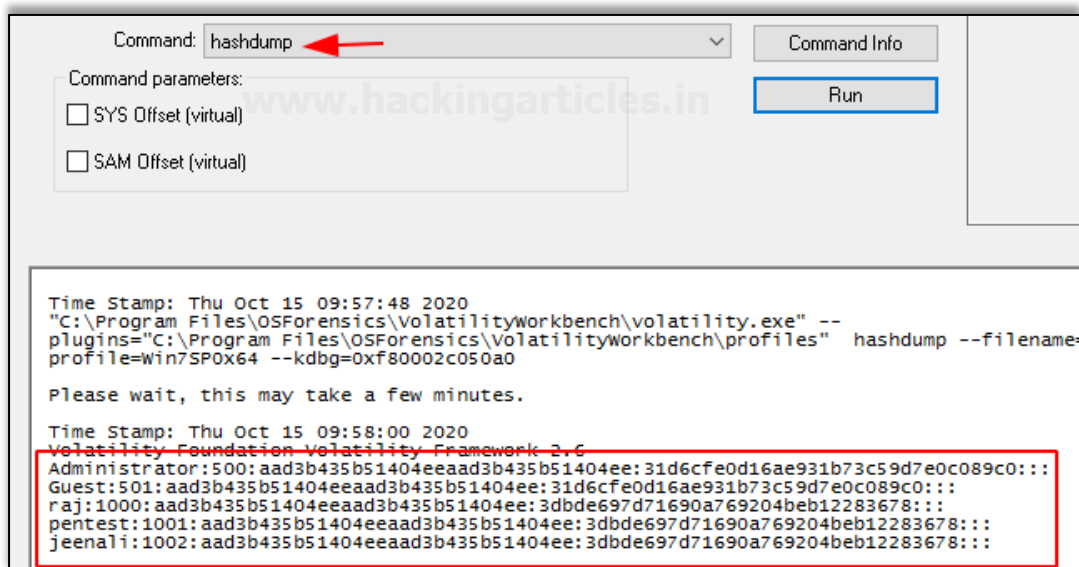
25. Printkey

This command is used to display the values, data, subkeys, and data types that are present in a specified registry.



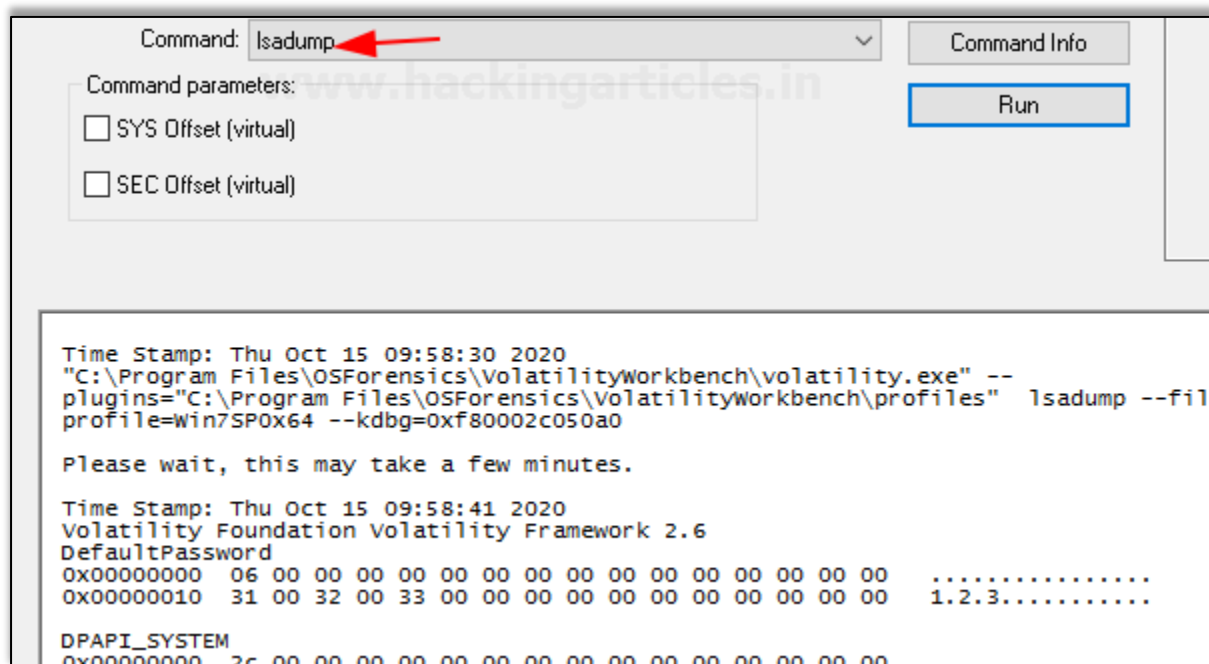
26. Hashdump

This command can be used to extract and decrypt cached domain credentials stored in the registry which can be availed from the memory dump. The hashes that are availed from the memory dump can be cracked using John the Ripper, Hashcat, etc



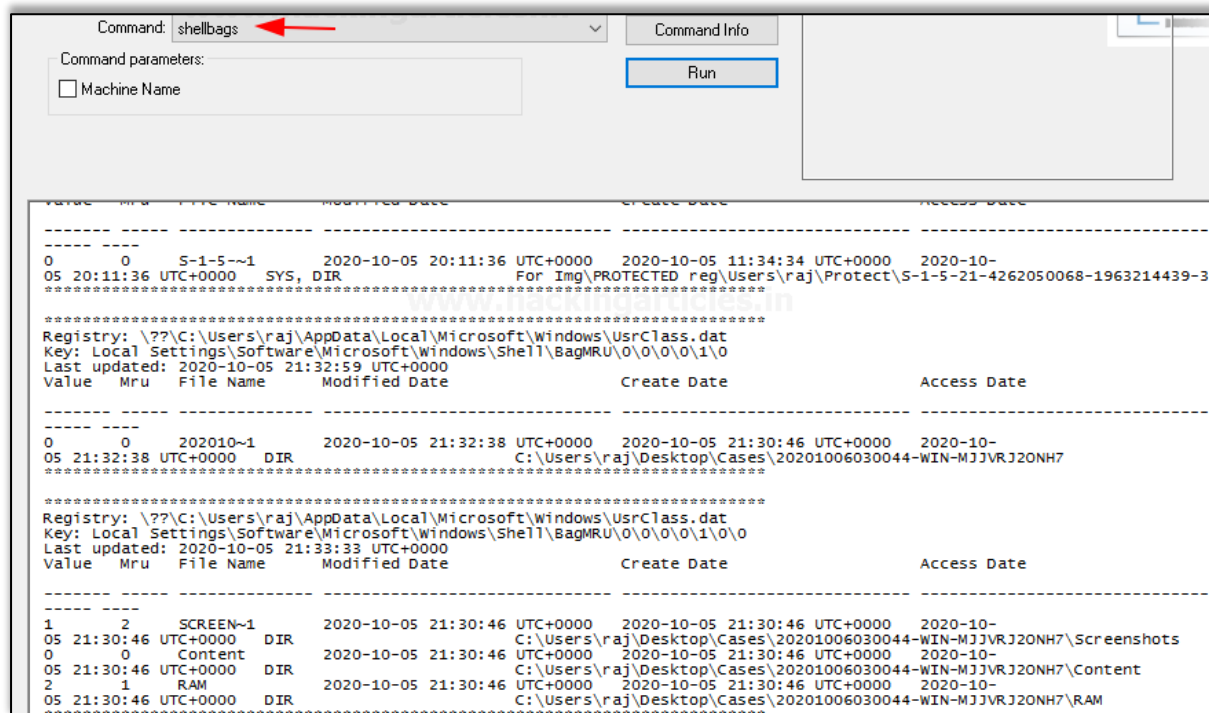
27. Lsadump

This command is used to dump LSA secrets from the registry in the memory dump. This plugin gives out information like the default password, the RDP public key, etc.



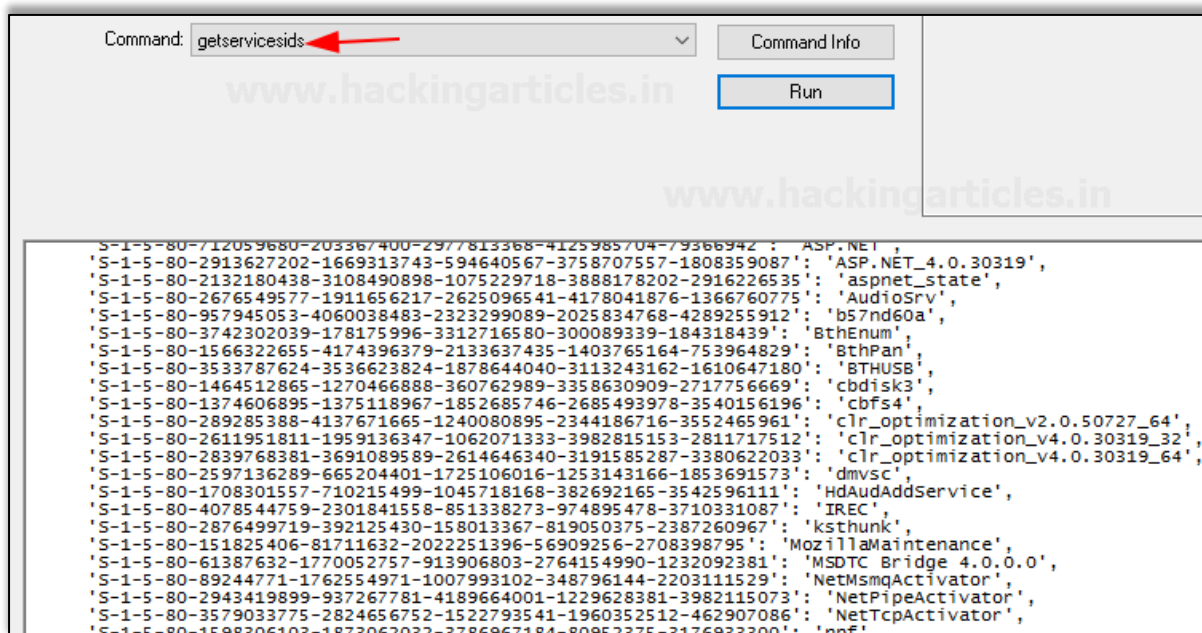
28. Shellbags

This command usually parses and prints the shellbag information that is obtained from the registry.



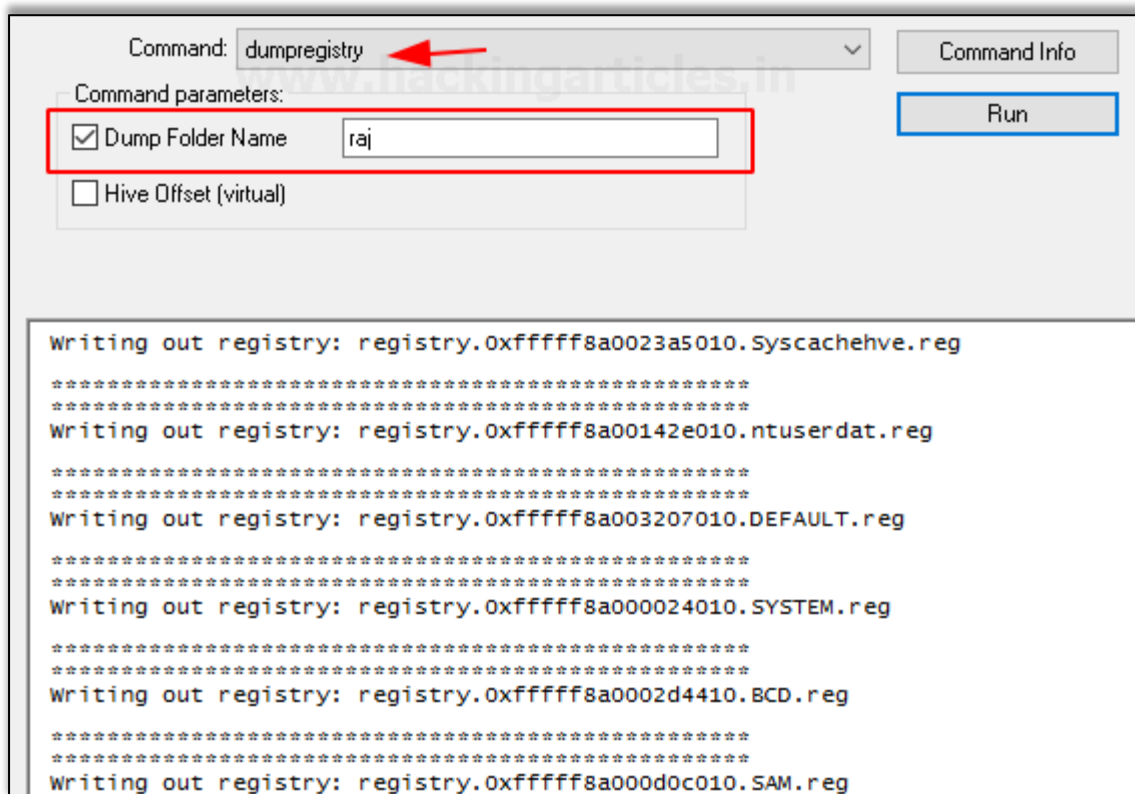
29. Getservicesids

This command does the work of calculating the SIDz for the services that are present on the machine. The name of the services has been taken from the registry.



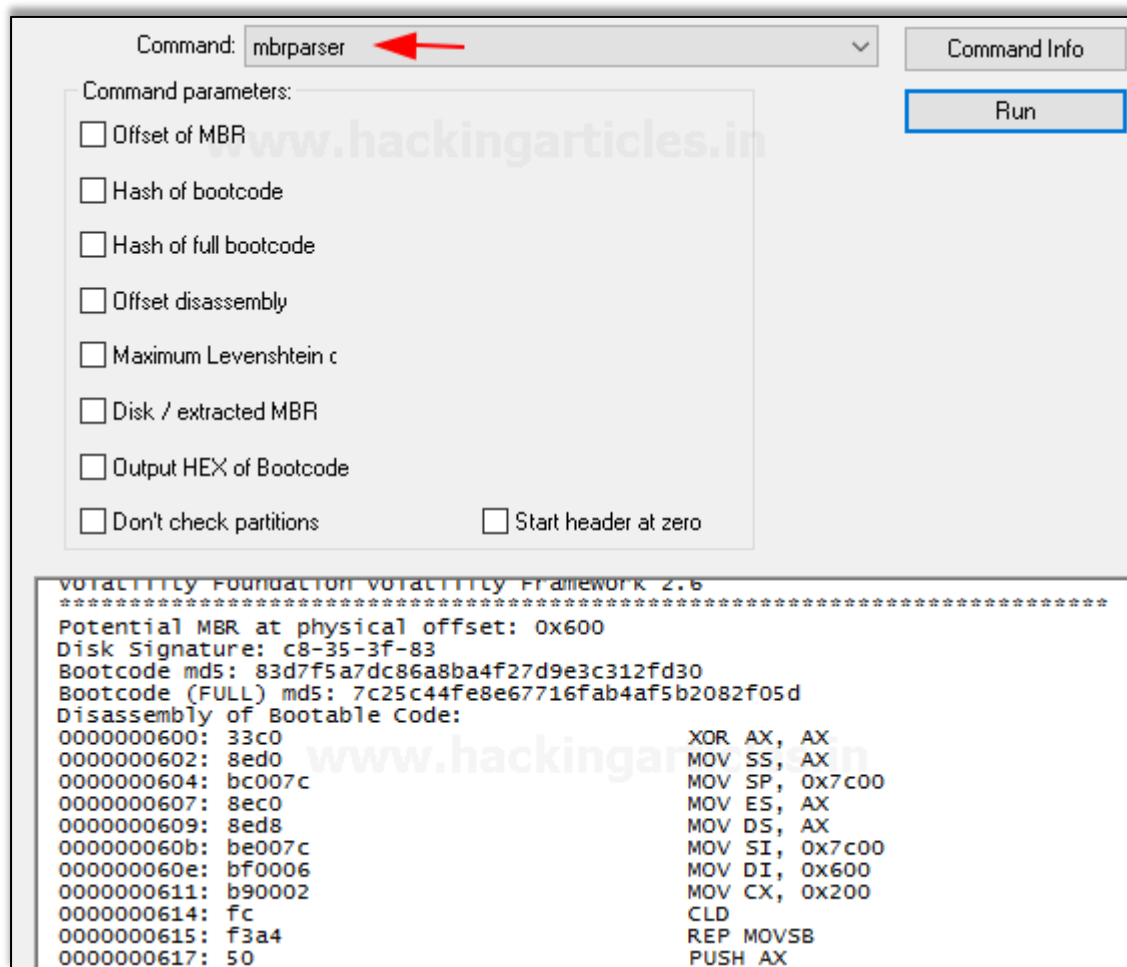
30. Dumpregistry

This plugin allows one to dump a registry hive into a disk location.



31. Mbrparser

This command scans and parses potential MBR from the memory dump. There are various ways to find MBR and the way of filtering it.



32. Mftparser

This command is used to scan the MFT entries in the memory dump and prints out the information for certain types of file attributes.

Command: **mftparser**

Command parameters:

- ☐ Machine Name
- ☐ Dump Folder Name
- ☐ MFT Entry Size
- ☐ MFT Offset (physical)
- ☐ Don't check partitions
- ☐ Debugging messages

Run

Scanning for MFT entries and building directory, this can take a while

 MFT entry found at offset 0x153000
 Attribute: In Use & File
 Record Number: 41432
 Link count: 2

\$STANDARD_INFORMATION		
Creation	Modified	MFT Altered
2010-11-21 07:06:28 UTC+0000	2010-11-21 07:06:28 UTC+0000	2020-10-06 01:01:13 UTC+0000

\$FILE_NAME		
Creation	Modified	MFT Altered
2020-10-06 01:01:13 UTC+0000	2020-10-06 01:01:13 UTC+0000	2020-10-06 01:01:13 UTC+0000

\$FILE_NAME		
Creation	Modified	MFT Altered
2020-10-06 01:01:13 UTC+0000	2020-10-06 01:01:13 UTC+0000	2020-10-06 01:01:13 UTC+0000

\$DATA

 MFT entry found at offset 0x153400
 Attribute: In Use & File
 Record Number: 41433
 Link count: 3

References

- <https://www.hackingarticles.in/memory-forensics-using-volatility-framework/>
- <https://www.hackingarticles.in/memory-forensics-using-volatility-workbench/>

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